Emotion and social context in a digital game experience

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Contents

Abstract

Arguably, the emotions elicited by playing are the reason why people play digital games. Social interaction is an important source of emotion during game play, but research on it is rather sparse. In this dissertation I briefly review the emotion-theoretic literature in order to better understand what emotion means in the context of games, and how this should be taken into account when measuring emotions related to a game experience. Study I presents a review of the use of psychophysiological methods in game research. I show that the theoretical background behind these methods generally tends to be neglected. This could be remedied by a theoretical framework that integrates the understanding of emotions and explicitly describes the links between different emotion measures and the theoretical concepts they are professed to reflect. I present my proposition for the first step towards such a framework in Study II.

I employ the sociality characteristics framework by de Kort and IJsselsteijn (2008) and my interpretation of the social factors in order to study the effect of the central social context factors on the emotional game experience. Study III presents evidence that in addition to tonic physiological levels, the relationship between the participants also affects the momentary, phasic responses to the key game events—victory and defeat. In particular, although physiological signals can, to a certain extent, be used to assess emotional experiences (such as positive responses to a victory), in some cases the typical psychophysiological mappings may even be completely opposite. Interpreting these signals requires a broader theoretical understanding than what is typically acknowledged. Study IV supports the earlier findings that competition is experienced more positively than cooperation—but that the effect is dependent on gender, as this was found only in males. For females, there was no difference between the two modes, and no difference in negative activation. In addition, self-reports concerning social presence suggested that this concept is not always associated with higher positive emotions, while a form of friendly rivalry (associated with lower social presence) might be experienced positively—a finding apparently new in existing literature. Finally, Study V provides insight into the practical significance of the measurements with a predictive validity study, showing practical effects how the

certain kinds of game experiences may lead to greater game use and preference, but that these links are not as simple as previously suggested.

In sum, this work offers new knowledge on how social context factors are generally related to the game experience, on how emotions can be studied in game research and what theoretical considerations should be taken into account, and on the emotional effects of particular social context factors during play. The results are mainly useful for further basic game research, but they have also potential implications for general emotion research, the game industry, and in the long run, society at large.

Tiivistelmä

Digitaalisten pelien herättämiä tunnekokemuksia on pidetty tärkeänä selittäjänä näiden suosiolle. Sosiaalinen vuorovaikutus pelin aikana taas on merkittävä tunnekokemuksien lähde, mutta sitä on tutkittu melko vähän. Tässä väitöskirjassa käyn osaksi läpi tunteita selittävää emootioteoriakirjallisuutta tarkastellakseni mitä tunteen tai emootion käsite tarkoittaa pelikontekstissa ja kuinka tämä tieto tulisi ottaa huomioon kun tunnekokemusta halutaan mitata pelitutkimuksessa. Tutkimus I esittää katsauksen psykofysiologisten menetelmien käytöstä pelitutkimuksessa, jonka avulla osoitan kuinka näiden menetelmien taustalla oleva teoreettinen perusta jätetään usein huomiotta. Tähän tyypilliseen puutteeseen olisi avuksi kokonaisvaltainen teoreettinen emootioiden ja niiden mittaamisen viitekehys. Esitän oman ehdotukseni kyseisenlaisen viitekehyksen suuntaan Tutkimuksessa II.

Käytän tutkimukseni empiirisessä osuudessa tulkintaani de Kortin ja IJsselsteijnin (2008) teoreettisesta viitekehyksestä sosiaalisuuspiirteistä tutkiakseni merkittävien sosiaalisten tekijöiden merkitystä pelaamisen tunnekokemukselle. Tutkimuksessa III esitän todisteita, että pelaajien väliset suhteet vaikuttavat pitkien jaksojen keskiarvojen lisäksi myös yksittäisten tilanteiden—voiton ja häviön—laukaisemiin hetkellisiin reaktioihin. Tulokset osoittavat kuitenkin, että joissain tilanteissa reaktiot voivat olla odottamattomat, minkä vuoksi fysiologisten mittausten tulkinnassa tulisi käyttää laajempaa teoreettista ymmärrystä kuin on yleistä. Tutkimus IV:n tulokset tukevat aiempia löydöksiä, että peleissä kilpailu koetaan positiivisemmin kuin yhteistyö, mutta että tämä vaikutus riippuu sukupuolesta: tulos pätee vain miehiin, kun taas naiset eivät osoittaneet eroa näiden pelimuotojen välillä positiivisen eivätkä negatiivisen tunnereaktion suhteen. Lisäksi huomattiin, että sosiaalisen läsnäolon kokemuksella, joka on yleensä yhdistetty positiiviseen kokemukseen, ei ole selvää yhteyttä positiivisuuteen, kun taas emootiokirjallisuudessa esitetyn selityksen vastaisesti tietynlainen ystävällismielinen vahingonilo voidaan kokea positiivisena. Lopuksi, Tutkimus V esittää kuinka emootiomittauksilla voi olla käytännöllistä ennustevaliditeettia, missä tietynlaiset pelikokemukset voidaan yhdistää tulevaan

pelikäyttäytymiseen, mutta että nämä yhteydet eivät ole niin yksinkertaisia kuin on aiemmin esitetty.

Yhteenvetona, työni tarjoaa uutta tietoa siitä, mikä on sosiaalisten taustatekijöiden yleinen yhteys pelikokemukseen, kuinka emootioita voidaan tarkastella pelitutkimuksessa ja mitä teoreettisia näkökohtia tällöin tulisi ottaa huomioon, sekä siitä mitä ovat tiettyjen sosiaalisten taustatekijöiden emootiovaikutus pelikokemuksen aikana. Työn tuloksia voidaan käyttää lähinnä pelaamisen perustutkimuksessa, mutta niillä on myös mahdollista merkitystä yleisessä emootiotutkimuksessa, pelitutkimuksen käytännöllisessä soveltamisessa peliteollisuuden hyödyksi, sekä pitkällä aikavälillä myös laajempien yhteiskunnallisten kysymysten kannalta.

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Helsinki, November 2015 J Matias Kivikangas

List of original publications

This thesis is based on the following original articles, which are referred to in the text by the following Roman numerals:

I Kivikangas, J. M., Chanel, G., Cowley, B., Ekman, I., Salminen, M., Järvelä, S., & Ravaja, N. (2011). A review of the use of psychophysiological methods in game research. *Journal of Gaming and Virtual Worlds, 3*(3), 181–199.

II Kivikangas, J. M. (in press). Affect channel model of evaluation in the context of digital games. In G. Yannakakis and K. Karpouzis (Eds.) *Emotion in Games: Theory and Practice*, Springer.

III Kivikangas, J. M. & Ravaja, N. (2013). Emotional responses to victory and defeat as a function of opponent. *IEEE Transactions on Affective Computing, 4*(2), 173-182.

IV Kivikangas, J. M., Kätsyri, J., Järvelä, S., & Ravaja, N. (2014). Gender differences in emotional responses to cooperative and competitive game play. *PloS ONE, 9*(7), e100318.

V Kivikangas, J. M., Järvelä, S., Ravaja, N. (2015). *Positive and negative affect as predictors of digital game play and preference*. Manuscript submitted for publication.

Abbreviations and glossary

Abbr.	Unabbreviated	Description
EMG	Electromyography	Physiological measurement of muscle activity; in this work, particularly facial muscles: ZM, CS, OO.
ZM	Zygomaticus major	Cheek muscle group; used in smiling.
CS	Corrugator supercilii	Brow muscle; used in frowning.
OO	Orbicularis oculi	Muscles around the eyes; used in narrowing the eyes.
EDA	Electrodermal activity	Physiological measurements of skin conductance (SC); in this work, especially SC level.
SCL	Skin conductance level	EDA measurement where all the skin conductance activity is aggregated over a period of time.
HR	Heart rate	Physiological measurement of how often the heart beats.
FPS	First-person shooter	A digital game type where the game world is viewed from the eyes of the game character. Originally and typically these games have been shooting games.
AI	Artificial intelligence	In games, the artificial intelligence controlling game characters (in contrast to the entire game environment) in response to the player's actions.
-	Phasic physiological responses	Momentary physiological responses, typically elicited by a specific event in the stimulus. The "average response" to an event.
-	Tonic physiological responses	The averaged activity levels during a period of time, such as one experimental condition. The "average state" of the signal over that period.

1. Introduction

In a couple of decades, digital games[1] have risen from the position of children's toys of limited commercial and cultural significance to worldwide popularity. According to the US industry, more than half of the population of the US plays digital games (Entertainment Software Association, 2014) and the figures are similar in Finland (Kallio, Mäyrä, & Kaipainen, 2009). In addition to entertainment, games are used for many other purposes: for example, for education (Pivec & Pivec, 2011), therapy (Kharrazi, Lu, Gharghabi, & Coleman, 2012; B. Ferguson, 2012), crowdsourcing scientific calculation (Coren & Fast Company, 2011), and persuasion (e.g., helping to switch to healthier living habits; Valdivieso-López et al., 2013). Although digital games still have an ambivalent public image, they are now an integral part of our popular culture.

Relative to their importance in people's lives today, the psychology behind playing digital games is still relatively poorly understood. What is it in the feeling of playing games that attracts so many people? The psychology of games and gaming is important for learning how the playing is experienced (understanding the immediate effects playing has), how it affects the players in the longer run (the potential adverse and beneficial effects that affect the player's life outside the play), and why people play and how this knowledge can be used in design of further entertainment and serious applications (see e.g., Marczewski, 2013).

The present dissertation contributes to the basic research of how games are experienced at the moment of playing, to the theory of what such a phenomenon

[1] For the purposes of this study an exact definition for 'game' is not important; see Salen and Zimmerman (2004, Chapter 7) for a discussion on defining 'games' and 'play'.

I use the term 'digital games' to refer to any software commonly identified as games, regardless of the hardware running it. That covers common entertainment games readily available in modern Western popular culture and played on PCs, dedicated game consoles, tablets, and smartphones, but I see no reason to exclude serious games, games that have no video output, or software toys that lack many characteristics of games. I prefer 'digital games', because the commonly used alternatives, namely 'video games' and 'computer games', can be confusing as for long time they have been used in different contexts to cover either all (or nearly all) digital games or only games run on a particular platform ('video games' covering only console games and 'computer games' only games on PCs). 'Electronic games' would cover largely as broad set as 'digital games' without the abovementioned confusion, but I remember hearing that word the first time in my childhood in the 80's to refer to early monochrome handheld game consoles dedicated to a single game like Donkey Kong, which sounds too outdated.

is, and to the methodology of how it can be studied. Due to this broad focus, its contents are likely to be relevant also for purposes outside game research.

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Digital games are played largely due to the emotions they elicit (Oliver & Raney, 2011; Fang, Chan, Brzezinski, & Nair, 2010; Caroux, Isbister, Le Bigot, & Vibert, 2015). Fun or enjoyment are often cited as an experience that people seek from game play (Tamborini, Bowman, Eden, Grizzard, & Organ, 2010; Yannakakis & Hallam, 2008), and states like flow, engagement, or involvement (Csikszentmihalyi, 1991; Caroux et al., 2015) that are often linked to games are considered deeply emotional or are assumed to be a source of positive emotional experiences (Nacke & Lindley, 2008; Brown & Cairns, 2004). Intrinsic motivation—the motivation to do something because of the activity itself, because it is enjoyable or satisfying, as opposed to doing it for some outside benefits—is typically cited when explaining the pull of digital games (Ryan & Deci, 2000; Wang, Khoo, Liu, & Divaharan, 2008; Tamborini et al., 2010; Ryan, Rigby, & Przybylski, 2006). A similar idea is also present in consumer research, where games are understood as "hedonic products" (Holbrook, Chestnut, Oliva, & Greenleaf, 1984): things that are consumed because of the positive feelings they elicit (Hirschman & Holbrook, 1982; see Alba & Williams, 2013, for a current review on hedonic consumption). If one wants to understand the digital game experience[2], one should study the emotions occurring during it.

Social interaction is an important factor often mentioned to contribute to the motivation to play, and presumably, to the emotional experience of playing digital games (Cole & Griffiths, 2007; Kallio et al., 2009; Raney, Smith, & Baker, 2006; Jansz & Tanis, 2007). Yet for long, most game research focusing on the game experience focused on the single-player experience (e.g., Klimmt, Hartmann, & Frey, 2007; Mandryk, Inkpen, & Calvert, 2006; Cowley, Charles,

[2] Other terms used with roughly the same meaning include player experience, play experience, and gameplay experience, depending on what the author wishes to emphasize. My (ultimately a somewhat arbitrary) choice is 'digital game experience', because although the 'player experience' more accurately expresses exactly the fact that the experience is not a product of the game only, it remains ambiguous on which kind of play it talks about (children's pretend play? theatric play? tabletop or live-action role-play?). In my opinion, it is better to start with a relatively strict term, and when necessary, clarify that this covers the whole experience related to playing a digital game. For practical reasons, the term gets shortened to 'game experience' in most cases.

Black, & Hickey, 2008; see also Caroux et al., 2015), and the rare exceptions that seriously considered the social aspect (e.g., Sweetser & Wyeth, 2005) did not gain wide support in game research (although neither did any other—to this day, the game experience research lacks a widely established theoretical framework). After the rise of massively multiplayer online (MMO) gaming, scholars began investigating why people play online games (Yee, 2006; Cole & Griffiths, 2007; Frostling-Henningsson, 2009; Billieux & Linden, 2013). Being about multiplayer games, these studies consistently acknowledged that the social aspect is one of the main attractions in these games (see also, e.g., "relatedness" in Tamborini et al., 2010). But this research ignores two important points. First, most of these studies have been focused on the game play as a hobby or an activity, ignoring the game experience at the moment of play. Second, the focus on online multiplayer games ignores that a lot of social play occurs locally, in the same room with other people—for example, when a child and an adult or friends play together rather to be with other people than for the game itself (Kallio, Mäyrä, & Kaipainen, 2010). This second oversight was noted by de Kort and IJsselsteijn (2008), who presented a research framework of "sociality characteristics" that affect the game experience in addition to the objective characteristics of the game itself. According to this framework, the players' emotional responses to game play would be heavily influenced by the social context, that is, factors such as who you are playing with, how and how much do you get information from them, how you are physically situated in relation to each other, and so on.

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The aim of this dissertation is to understand better the emotions of a digital game experience during local social game play. I have two approaches. On one hand, I use the sociality characteristics framework to identify (some of the) important social factors that affect the emotional game experience, and investigate those factors experimentally. I focus on the local (i.e., not online) social factors, because despite their importance, they have garnered less attention than online sociality. On the other hand, I take a critical look at measuring emotions and assess current common emotion measurement methods in relation to emotion theories, in order to improve the understanding of the measures and the theoretical constructs they are presumed to correspond to. Because of the ubiquity of emotions and neighboring concepts and frameworks (e.g., motivation, mood management) in game research literature, I focus on emotions as they are understood in psychological theories of emotion. In the empirical articles, I use both self-report and psychophysiological measurements, and in the discussion of this dissertation, I apply the results from the critical approach to reframe the empirical results in light of the broader theoretical understanding.

The research questions for this dissertation are the following.

1. How should emotions be understood and measured (in game research)? Everyone thinks they know what emotions are because they experience them daily. But as I will show, the concept of emotion is not clear, and measuring them is even less so. I argue that the field needs a more critical look at the measures, and a theoretical framework that offers a more multifaceted view on emotions, and I offer the first version of such a framework.

2. How do certain social context factors affect the (emotional) game experience? Some previous results exist, but the evidence is scarce and conflicting, and it routinely does not take into account the theoretical constraints of measuring emotions. I show the relationship of my empirical investigations to earlier studies in regard to the factors identified within the sociality characteristics model, and I build my experiments on the existing empirical knowledge on those factors. In addition, I use the newly created emotion-theoretical framework to make new interpretations of the empirical results.

The contents of the introduction proceed as follows. In section 1.1, I review the sociality characteristics framework and the current empirical research on contextual factors. While reviewing the existing studies I use the word ‘emotion’ and related terms in the way they are used in these studies; after that, I take a look at the concept closer in section 1.2. I briefly review the current theoretical understanding of emotions and describe the common methods of measuring them in the game research field. At the end, I take a critical look at what it means to measure emotions. Before moving on to the sections covering the methods and results of this work, I reiterate my aims.

1.1. Social context in digital games

As mentioned, social interaction is an important factor in why people play (Cole & Griffiths, 2007; Kallio et al., 2009; Raney et al., 2006; Jansz & Tanis, 2007). What kind of factors make up the social context?

Although de Kort and IJsselsteijn (2008) most concretely discussed the influence of contextual factors involved in a digital game experience, other scholars had recognized something similar, especially on the cultural research or humanistic side of the game research field. Mäyrä (2007)[3] proposed that besides the game experience itself, researchers should look at the immediate personal and social contexts, the cultural game and play context and the context of the game's producers, and the wider context of social norms and values. While relevant and thoughtful suggestions, the proposed contextual game experience model was very abstract, without a more fine-grained structure for what comprises these contexts. A more current account, the contextual gameplay experience model by Engl and Nacke (2013) also operates on a very abstract level, and while the article discusses a spatial factor investigated in an empirical experiment, the social factors are not discussed.[4] In contrast, Christou and others (Christou, Law, Zaphiris, & Ang, 2013), Kultima and Stenros (2010), and Sweetser, Johnson, and Wyeth (2012) had a more practical approach, making concrete suggestions for designers. The aim for a direct applicability is recommendable, but as the focus is in guidelines for design, the use for research is not easy.

Considering the alternatives, the sociality characteristics model by de Kort & IJsselsteijn seems to be the least abstract and to have the most potential for

[3] Even further back, in their influential book, Salen and Zimmerman (2004) discussed both the game boundaries (what is and is not part of the game?) and the social (and cultural) aspect extensively. In fact, the concept of "magic circle"—that Salen and Zimmerman brought to academic attention (Huizinga, 1949)—is to this day widely discussed in humanistic/cultural game studies, debating the context of play as a central question (Stenros, 2014). In contrast to game research, as I have used the term in this work, the broader game studies field is not focusing exclusively on digital games, but include all kinds of games (board games, tabletop and live-action role-playing games, etc.). Without the digital computer to set some hard limits, the concept is certainly much more relevant than in digital games. The literature in the broader game studies field on the topic is so large that I do not even attempt to approach it. In this dissertation, I focus on digital games and their context, and consider only works that have studied the topic within the digital game research literature.

[4] A possible further contender is the integrated model of player experience (Elson, Breuer, & Quandt, 2014), which explicitly recognizes the play context as a third important aspect in addition to player and medium, but I did not have access to it at the time of writing.

practical use when considering empirical and experimental research of the context factors related to the game experience.

1.1.1. Sociality characteristics framework and model

De Kort & IJsselsteijn's work (2008) stemmed from the recognition that social play is more common than assumed: even in supposedly solitary play, many people play together by watching others play, commenting, and sharing the emotional experience the social interaction. In addition, the game experience was often seen as an interaction between the player and the game, with little attention paid to the context in which the play occurred (Klimmt, 2003; Cowley, Charles, Black, & Hickey, 2006). De Kort and IJsselsteijn state:

> "Our work is strongly inspired by the realisation that gaming is often as much about social interaction, as it is about interaction with the game content. Thus, the rich interactive experiences associated with gaming can only be fully understood when the game is conceptualised as more than the software and hardware one is interacting with locally, but includes a larger situational perspective, tapping in on the social-contextual contingencies that powerfully influence game interactions and associated experiences." (2008, p. 2)

The sociality characteristics framework (de Kort & IJsselsteijn, 2008) focuses on social affordances that the game, the game interface, and the setting create in a playing situation, and how they affect the game experience. In brief, the sociality characteristics are the features of the setting that shape the situation in a way that change how the people in the setting are aware of and can communicate and interact with each other. As de Kort and IJsselsteijn put it, the mere presence of another player does not influence the experience, as it depends on the player's ability to monitor it: if the physical, digital, or social features do not allow the player to recognize or even suspect that there is a co-player (e.g., in a psychological experiment where the player is told that the other character is player by the AI), obviously the mediated presence of that person cannot influence the social experience[5]. The result of the monitoring of all the social cues is the (sense of) social presence: the experience of being with

[5] Of course, there might be other differences that may influence the experience, such as different play style or performance than an AI might have, but the argument here is about the mere presence.

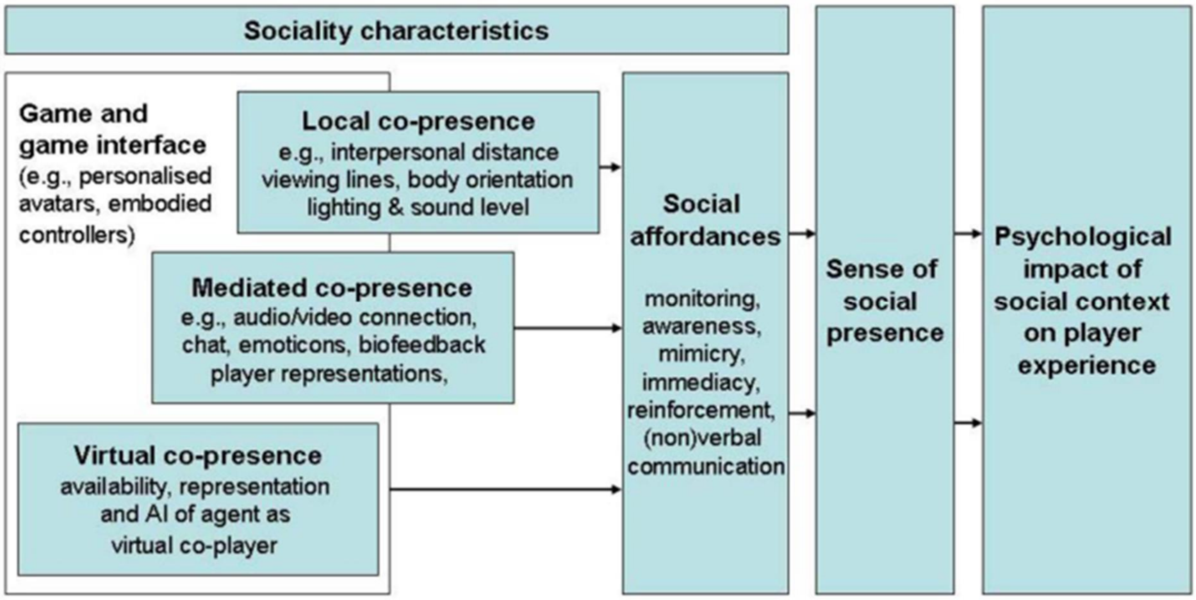

Figure 1. Framework for game settings' sociality characteristics for game experience, by de Kort and IJsselsteijn (2008). © Association for Computing Machinery, Inc. Reprinted by permission.

another, as defined by the original presenters of the concept (Biocca, Harms, & Burgoon, 2003). However, social presence is not supposed to represent simply the extent to which the participant has recognized the presence of another, but also "psychological involvement with another intelligence and behavioural engagement through interaction and synchronisation" (de Kort & IJsselsteijn, 2008, p. 6). Therefore, it is the result of detecting the social cues, but it also itself affects the game experience directly by virtue of being itself a positive experience[6], and further indirectly by moderating the effects of the social factors (i.e., they have less influence if the player is not involved with the other people). (Regarding this, the model in Figure 1 is a bit misleading: social presence is not meant to mediate the social context effects, as can be interpreted from the figure, but only to moderate them.)

It is notable that by explicating processes like social facilitation and emotional contagion as parts of social presence, de Kort and IJsselsteijn define its mechanisms largely as emotional. This shows also in the composition of the questionnaire they created for measuring social presence, which has subscales of empathy and negative feelings, in addition to behavioral mimicry (Social

[6] Although this ignores the fact that the presence of others—such as an annoying person—is not always positive.

Presence in Gaming Questionnaire; de Kort, IJsselsteijn, & Poels, 2007). Although de Kort and IJsselsteijn give examples of possible mechanisms and talk about what kind of things might be relevant, they do not offer a systematic model that would explicitly state what the parts are and what are their relationships to each other. In order to empirically study the social context factors, it would be necessary to explicate what they might be. Interpreting de Kort and IJsselsteijn's (2008) social characteristics framework as it has been described, I have derived that the factors could be broken into three context factors[7] (see Figure 2): (1) the physical and digital[8] features of the setting, (2) the presence and the type of presence of others, and (3) their relation to the player in the play situation (roles) and outside it (relationships).

The first factor covers the social affordances, or the opportunities the situation provides for monitoring the others and their actions, and for verbal and non-verbal communication. How the second factor is experienced depending on the first—how the experience of other's presence is affected by the physical and digital features of the setting—is in essence what is described in Figure 1. The physical and virtual features of the setting refer to things like how the participants are physically situated in relation to each other, can they see

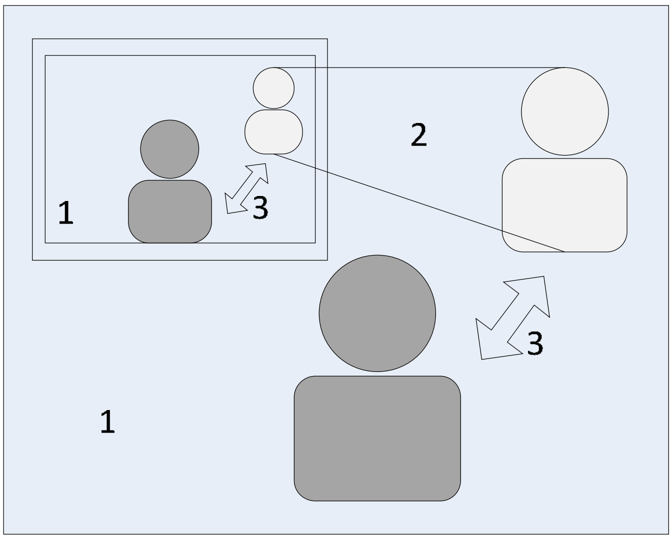

Figure 2. Interpretation of the three social context factors in the sociality characteristics framework.

[7] Sets of factors really, but I talk about factors for convenience's sake.

[8] By 'digital', I mean the features of the software—the game, the operating system, and other programs possibly influencing the social situation—as an distinction from the physical features such as the interpersonal distance and the body orientation of the participating persons.

each other easily while playing, how the players are represented in the game, and what are the concrete methods of communication. In addition to enabling communication and monitoring of social cues, the digital features also define much of the roles between the participants (specifically, the roles between the players within the game, but not of the audience). And of course, a great portion of the game experience—is it fun to play?—depends on the game, including how the multiplayer features are implemented: is it fun to play together? and also, is it fun to watch?

The second factor, presence of others, covers whether and how many others are present, and how they are present. De Kort and IJsselsteijn divide the types of presence into three categories that are intertwined with the physical and virtual features: local co-presence (being physically located next to each other), mediated co-presence (being physically apart but present in the game, and possibly able to communicate by, e.g., an audio connection, but at the least by some kind of player representation in the game), and virtual co-presence (an AI co-presence; i.e., no other human present)[9]. The social presence within all these categories may vary according to the physical, but also the virtual setting, so that co-located situations, despite in principle allowing more direct communication, are not always experienced as more social. For example, if the digital features separate the players within the game world and do not give any incentive to interact (e.g., shooting the same enemies in the same environment, but without any reason for the PCs to help each other), a local co-presence can mean that the players simply sit beside each other while playing but don't talk to or otherwise interact with each other. Note also the difference between the virtual co-presence and a proper single-player game: although the player is without a human co-player in both, a game with a virtual co-presence involves some kind of role or player character that might be controlled by a human but is not, whereas in a proper single-player game the game is built so that the player

[9] The types discussed by de Kort and IJsselsteijn are related to the level of mediation (of which the AI co-presence is considered an extreme example, which might be criticized). Other variables might be relevant to consider as well. One example is knowledge of presence without mediation: an audience that the player knows to be there but that does not interact with them—for instance in professional e-sports, or when streaming game content online. It is likely that the knowledge influences the experience, similar to how the mere knowledge of the relationship of the co-player influences it (Ravaja, 2009).

is alone by design. This difference in design—whether everything in the game have been thought out so that they could work for several players as well as for only a single player, or whether the designers have been able to focus on designing the game solely for a single-player experience—might have a great impact on the game experience, and in addition to the importance to recognize this difference in any model about a game experience, the difference is also paramount for experimental control.

The third factor, the relations between the participants, is also an important one: it is different to play with your child, friend, spouse, father, or boss, or with a stranger—the relationship outside the situation (cf. Jakobs & Fischer, 1997). This effect interacts with the roles within the situation that are partly set by the digital features. It is different to play while the other watches, or to play in cooperation with that person or to compete with them; to play a game where the skills of the players, or the roles or abilities within the game are clearly unequal; or to play for fun vs. playing for money. The relationship effects are assumed to be more pronounced when the social presence increases, and vice versa.

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Despite being the most concrete look at the topic, the SCF still operates on a rather high level, and like the other models, it discusses little about what the effects might actually be. An important reason was surely that there was not much research on the social factors at the time. After 2008, however, several empirical studies have investigated relevant social factors and their effects on the emotional game experience. My interpretation above is of course influenced by the empirical studies now available.

1.1.2. Current empirical research on social context

1.1.2.1. Co-presence and relationship effects

The second and third factors are the most obvious ones, and the most studied (which is probably why de Kort and IJsselsteijn focused on the more neglected first one in their paper). The social context is influenced by the other people—by whether they are present, and by who they are. There are several studies on the effect of games played with a human and virtual co-presence, with both physiological and self-reported measures. This comparison has been extended especially with examinations of two separate factors, one focusing on the type of co-presence (local, mediated, and virtual co-presence), and the other on the relationship between the players.

Effects of the type of co-presence has been since directly tested by Gajadhar and others in cooperation with de Kort and IJsselsteijn, with self-report measures of positive affect, social presence, and other constructs. They report that player enjoyment increased from virtual/mediated co-presence (no difference between these two) to local co-presence, and that social presence mediated this effect (Gajadhar, de Kort, & IJsselsteijn, 2008). Interestingly, when senior participants were investigated (Gajadhar, Nap, de Kort, & IJsselsteijn, 2010), the virtual and the local co-presence conditions did not differ in positive affect, and mediated co-presence was actually experienced as less positive; social presence was also found to mediate the effects. Mediated vs. virtual co-presence was also studied by Weibel and others, who found that self-reported enjoyment (along with flow and spatial presence) was higher when playing with a human (Weibel, Wissmath, Habegger, Steiner, & Groner, 2008); the same findings were reported by Merritt and others (2011), and Lim and Reeves (2010, although due to the restricted nature of the game setting, the ecological validity of this study is suspect). As a good display of experimental control, in all these studies the mediated and virtual conditions were actually identical except for the fact that the participants were told that in one they played against a human and in another against an AI (in the Gajadhar and Lim & Reeves studies the purported virtual conditions were also played by a human, and in Merritt and Weibel studies the purported mediated condition was played by an AI). Furthermore, some studies controlled for the performance in the game: winning the game was associated with more enjoyment than losing, but the effect was small and uncertain and did not explain the differences between the conditions (Gajadhar et al., 2008; Gajadhar, de Kort, & IJsselsteijn, 2009; Merritt et al., 2011, had similar results).

The relationship of players was also manipulated in the Gajadhar and others' (2008) study, employing both friends and strangers as opponents, but they found differences only in social presence (more in the friend condition) and not in positive affect. Mandryk and others focused on methodology on their two studies, but also provided preliminary (with a small sample of 10) physiological evidence for the effects of playing locally against a friend vs. a computer AI (Mandryk, Inkpen, et al., 2006), and evidence for the difference in experience between playing locally against a friend vs. a stranger vs. an AI (Mandryk & Atkins, 2007): in all cases, the physiological signals indicated higher positive affect when the opponent was a human and lower when playing against a virtual co-presence. Further, this effect may be facilitated if the other player is a friend instead of a stranger, although the effect seems to be smaller and more uncertain. These findings have been also found independently in our own lab for differences between a friend, a stranger, and a computer AI in a locally played game (Ravaja, Saari, Turpeinen, et al., 2006), and for the same conditions but with mediated co-presence (players located in different rooms) instead of local co-presence (Ravaja, 2009).

The Ravaja and Mandryk studies did not include a social presence measure (although both Ravaja studies reported the related self-report measures of engagement and spatial presence, which seemed to follow the same pattern as positive affect). On the other hand, Cairns and others (Cairns, Cox, & Day, 2013) report that social presence was higher in a co-located than mediated condition (a finding also repeated by Martin, 2010) and higher in a mediated than virtual condition (as was immersion, in contrast to local vs mediated comparison). (They also report difference between friend and stranger opponents, but only for immersion and with only nine stranger participants.)

In sum, a rather robust (independent of the wide range of measurements used) finding seems to be that playing with a human is experienced as more positive than playing with a virtual co-presence of a computer-controlled AI. The positive affect is probably higher in both the mediated co-presence (instead of local) and the stranger-relationship (instead of a friend) contexts in relation to a virtual co-presence context, but not as much as a local and/or friend co-player would. However, the exception by the senior sample—who reported the mediated co-presence as the least positive, and the virtual co-presence as equally positive to local (Gajadhar et al., 2009)—calls for caution when generalizing the results, as an apparently atypical sample significantly deviated from the pattern. Interestingly, although the social presence seems to be associated with the emotional effects as proposed by de Kort and IJsselsteijn (2008), the positive affect did not covary with social presence (Gajadhar et al., 2008).

1.1.2.2. Competition and cooperation

Another topic rather widely studied is the relationship between the players within the play situation, namely, the comparison between competition and cooperation (purview of the third factor). However, this is mainly due to the importance of the topic outside game research, focusing on outcome variables such as cooperativeness after and outside the game (Ewoldsen et al., 2012) and aggressiveness (Schmierbach, 2010), or motivation in exergames (Peng & Hsieh, 2012). A few of the aggression studies have measured self-reported arousal, but with conflicting evidence, one reporting that cooperative play is experienced as less arousing, but only for males (Schmierbach, 2010), and another reporting that cooperative play was experienced as more arousing (with apparently no analysis on the influence of gender; Velez, Mahood, Ewoldsen, & Moyer-Guse, 2012). While the evidence here is weak, the potential difference between males and females in regard to competition is well established at least in behavioral economics in that males prefer it to cooperation while females do not (e.g., Niederle & Vesterlund, 2008; Gneezy & Rustichini, 2004).

Within game research, an early theoretical work suggested that competition is critical for enjoyment in games (Vorderer, Hartmann, & Klimmt, 2003), and this has been also found in survey studies on game motivation (e.g., Sherry, Lucas, Greenberg, & Lachlan, 2006). Schmierbach and others (2012) reported that competitive game mode indeed was self-reported as more enjoyable than cooperative, while Emmerich and Masuch (2013) reported higher positive affect for competitive mode and no difference in negative affect; however, competitive mode was associated with lower social presence. The only study reporting effects on physiological measurements was by Lim and Reeves (2010), who reported higher arousal (SC and HR) during competition across co-presence conditions, in addition to lower self-reported valence (in the virtual co-presence conditions only). Emmerich and Masuch report no differences between genders, while the other studies did not report testing gender differences in the first place.

As a summary, there is some evidence for higher (self-reported) positive affect during competition, as compared to cooperation, but conflicting evidence whether this effect is influenced by gender or whether arousal would be higher in competition or cooperation. Contrary to expectations based on the SCM, in one study, social presence and positive affect had a negative association.

1.1.2.3. Physical features

As opposed to academic interest on competition and cooperation originating from other research fields, studies on the physical context of game play have been more exploratory in their methods, using case studies or very weakly controlled experiments in their search for practical solutions. Of the more convincing ones, de Grove and others examined the influence of school vs. home as the playing environment for a learning game (De Grove, Cauberghe, & Van Looy, 2014). The playing was enjoyed more at home, although when playing time and technical performance were controlled, the difference disappeared. Jurgelionis and others made a similar comparison between a public internet café and home, reporting barely higher self-reported positive affect at home (in addition to higher flow and lower boredom; Jurgelionis et al., 2011). However, Engl and Nacke (2013) compared mobile (in a tram) play environment to home, and found no difference in self-reported positive affect, but higher negative affect (and immersion) in the mobile context. Further analyses revealed that the higher negative affect was reported by males but not by females. All studies included only implicit social context (other people present, but not specifically participating in play) in the non-home condition.

Communication affordances have been studied by Shahid and others, who compared the effects of a local co-presence and two different video-mediated conditions, one with a possibility for a mutual gaze and one without, in child participants (Shahid, Krahmer, & Swerts, 2012). They found that the gaze condition was reported to be more fun than the local co-presence condition, while the no gaze condition was the least fun (and the least engaging, compared to the other two), in line with assumptions by the SCF. A video chat (apparently with a gaze opportunity) was also found more fun than no video-mediation by young adults and seniors in a case study (Derboven, Van Gils, & De Grooff, 2011). However, Gajadhar and others investigated the presence of video and audio communication during play, and found no difference in self-reported positive affect between no communication, only video, only audio, or both audio and video (Gajadhar et al., 2009; although flow increased and frustration decreased linearly across these conditions).

In sum, when comparing home to other playing environments, the home might be experienced more positively, but the evidence is contradictory and the studies are not well controlled. Same can be said about communication affordances: possible support for the higher affordances for experienced communication more positively, but the studies are weak and partly contradictory. Evidence also exists for the influence of superficial physical factors on media experience (such as screen size; e.g., Reeves, Lang, Kim, & Tatar, 1999; Ravaja, Saari, Kallinen, & Laarni, 2006), but less on games (but see screen size and game camera perspective; Hou, Nam, Peng, & Lee, 2012; Kallinen, Salminen, Ravaja, Kedzior, & Sääksjärvi, 2007), and to my knowledge none that are taking the social context into account.

1.1.2.4. Audience effects

The presence of another is typically considered to be in the role of an active co-player, but the other possibility is in the role of an audience (cf. Kallio et al., 2010). There are studies that suggest different audience effects—again, contradictory findings for emotional experience (Bowman, Weber, Tamborini, & Sherry, 2013; Downs, Vetere, Howard, Loughnan, & Smith, 2014; Kappen et al., 2014), but also interesting suggestions on effects of anticipation and play around the turn-taking (Downs, Vetere, & Howard, 2013)—but as they are outside the focus of this dissertation, I will not discuss them further.

1.1.2.5. Social presence and physiological linkage

As defined earlier, social presence is the feeling of being with others (Biocca et al., 2003), and arguably it is both affected by the social affordances provided by the contextual factors, and in turn it then affects the game experience in a play situation (de Kort & IJsselsteijn, 2008). In addition to the original self-report instrument by Biocca and Harms (Biocca & Harms, 2003), social presence can also be assessed by the questionnaire specifically developed for the game context (de Kort et al., 2007), which is used by all the empirical studies on games reporting social presence above. In a previous article my colleagues and I presented an alternative metric related to social presence (I. Ekman et al., 2012): physiological linkage (also called compliance), a synchronization of physiological signals between two (or more) players in a social situation. Physiological linkage has been found to increase when people intensively interact with each other (Hatfield, Cacioppo, & Rapson, 1993; Kimura & Daibo, 2006), and it is correlated with the accuracy to perceive others' emotions (related to empathy; Levenson & Ruef, 1992) and mutual understanding (Järvelä, Chanel, Kuikkaniemi, & Ravaja, 2011), and it can be used to estimate team performance on collaborative tasks (Elkins et al., 2009; Henning, Boucsein, & Gil, 2001). It is thought to originate from the unconscious tendency to imitate other people, based on the automatic evaluations and mental simulation that constitute our understanding of others (Adolphs, 2003; Spapé et al., 2013), but both the theoretical and practical understanding of it are still very limited.

While physiological linkage offers an intriguing opportunity for measurements of a central variable in the SCF, its background and practical use falls beyond the focus of this work.

1.1.2.6. Conclusion

The sociality characteristics framework provides a conceptual tool for understanding how the game experience is influenced by the social context. My interpretation of the three social context factors concretizes this understanding to making sense of the mutual relationships between the factors and identifying the individual effects. Although there is considerably more empirical research on social context factors now than in 2008, the topic is far from exhausted.

Preliminary evidence is now available for effects of all three context factors, although much of it was conflicting and/or weak. However, in addition to the factors, SCF describes how the factors determine the affordances, which in turn determine the social presence, which both is part of the game experience (as social presence is assumed to be a positive experience) and also influences it as a moderator for the factors. Unfortunately, there is currently no research on these later steps of the model. The little evidence on the association between the valence of game experience and social presence was contradictory, suggesting that the relationship between them is possibly not as straightforward as presented in the SCF.

1.2. Emotion

As can be seen from the previous section, it is not rare that digital game research discusses emotions or even that apparently emotional terms (such as "enjoyment", "fun", "boredom", and "anxiety") are used as key concepts. However, as the game researchers come from widely different backgrounds, ranging from computer sciences to cultural studies to various fields of psychology, the understanding of what emotions are, how they work (what is their effect), and how could they be measured, varies significantly. And although there is a century-old tradition of emotion research in psychology, this literature is almost[10] never utilized in game research.

One reason, no doubt, is the fragmented situation of the emotion theories: after a century of emotion research, different theories attempting to explain how emotions work are counted in dozens, if not hundreds, and the researchers still cannot agree on what an emotion is (for more details, see the two Special sections on the topic that ultimately do not reach a conclusion, in the journal Emotion Review: Izard, 2010; Russell, 2012). With the theories also often focusing on very specific features of the complicated phenomena of emotions, they are also difficult to apply to a specialized field with complex and still relatively poorly understood stimuli, such as digital games. As a result, most game experience research has little or no connection to the emotion literature (for a rare and undervalued exception, see A. Lang, 2006).

1.2.1. A brief look into current emotion theories

Despite the differences, there are certain basics that almost everyone in psychological research of emotion now agrees on. Most importantly, the

[10] As the most notable exception, the psychophysiological approach to games is the most connected to the current emotion research. I'll return to this a bit later.

neuroscientific and psychophysiological research has provided so much evidence of the (neuro)physiological basis of emotions that it has been seen as a paradigm shift in Kuhnian sense, changing the focus of the concept itself from subjective experiences to the neural perspective (P. J. Lang, 2014). Neural pathways and brain structures that carry and process emotional information have been investigated and identified (to an extent; see e.g., Panksepp, 2008) as well as autonomic nervous system (ANS) responses related to emotion (e.g., Kreibig, 2010), and these findings have been recognized among (although not always integrated to) the emotion theories. Practically all current theories make their own interpretations on how these findings support their particular view.

A broad consensus also now holds that emotions constitute evolutionary adaptations to regulate behavior of an individual in ways that increased genetic propagation by our mammalian and even more distant ancestors (Tooby & Cosmides, 2008; LeDoux, 2012). Evolutionary emergence of higher neural structures did not replace the more primitive organizations, however, but instead organized on top of them, developing experience-dependent associative knowledge system, more powerful anticipatory information processing, and eventually conscious strategies to cope with the primal survival functions. At the same time, however, it is important to notice that evolutionary development of emotions does not make them (entirely) genetically determined: it has evolved with our cognitive ability to be flexible, to answer different challenges in different environments and situations. That flexibility manifests in how surrounding culture and the personal history modify the individual emotional responses to different culturally and personally salient situations (Mesquita & Boiger, 2014).

Finally, emotions are largely acknowledged to include different kinds of signals we associate with emotions, often called emotion components (Mauss & Robinson, 2009): typically (1) the facial, vocal, and bodily expressions (e.g., smiling or frowning, aggressive or lowered voice, diminished or withdrawing posture); (2) the physiological responses (e.g., heart rate, changes in autonomic nervous system activation); (3) the behavior or behavioral tendency (e.g., attacking, fleeing); and (4) the subjective feeling (e.g., feeling afraid or happy). Sometimes other components are also included, especially appraisal, which refers to the automatic evaluation of particular features of the stimulus or situation in order to determine the suitable emotional reaction (Scherer, 2005; also see appraisal theories below). All these are phenomena that a theory of emotion is supposed to explain. While in the past it was thought that ‘emotion’ is something that caused the changes in these components (Russell, 2003, pp. 151–152), scholars now widely reject this essentialist notion: if emotion causes the components, what is emotion? Emotion does not have an ‘essence’, it is not a particular naturally demarcated thing we could simply point and name (Barrett, 2013)—instead the word ‘emotion’ can be used as a descriptor for the whole process that leads to the components, or simply for the collection of the components themselves (Zachar, 2014).

1.2.1.1. Four theory families

Apart from these common agreements, the different theories strongly disagree on how emotions are formed, from which fundamental parts, and to which extent automatically elicited or cognitively constructed. The most prominent emotion theories can be grouped roughly into four theory families: basic emotion theories, constructionist theories, dimensional theories, and appraisal theories.

When trying to explain what emotions are and how they work, one intuitively thinks about situations where the experience has been as clear as possible, and how they differ from other situations: surely we can start from the fact that fear and anger and happiness are all different from each other? They feel different, and look different to an outside observer, in how they are expressed, and how they make people behave. One of the oldest and historically most popular views starts with this intuition. Basic emotion theories posit that certain basic emotions (sometimes called discrete or distinct emotions) with distinct subjective feelings—such as anger, fear, sadness, and happiness, but probably not those such as jealousy, embarrassment, or excitement, although this varies across theories—are discrete categories (clearly distinct from each other) and universal (same across cultures and individuals). Most add that while other emotional feelings may exist, the basic emotions are fundamental and the others, like the jealousy and the others mentioned above, are based on them;

and that basic emotions are separately evolved adaptations with specific neural circuitries that activate in response to specific salient stimuli types to function as specific behavior programs beneficial in that emotional situation (e.g., P. Ekman & Cordaro, 2011; Panksepp, 2004; Levenson, 2011). Typically basic emotion theories list the particular emotions (which may be emotion families or categories instead of singular emotions) they consider basic on various grounds and define ‘emotion’ to refer only to these categories. Some basic emotion theorists focus on the external components (especially the traditional view by P. Ekman, 1999), but many current theories emphasize the internal neuroscientific signals and the evolutionary perspective (e.g., Levenson, 2011; Panksepp & Watt, 2011; Tracy, 2014). Due to evidence of emotion-specific neural circuits, neuroscientists are often grouped among basic emotion theorists, even when they explicitly deny it themselves (e.g., LeDoux, 2014). (See Russell, Rosenberg, & Lewis, 2011, for the contemporary look at basic emotions.)

Theories that call themselves constructionist ones are currently, and have historically been, largely a reaction to basic emotion theories, because they disagree that fixed categories can adequately describe emotion (Barrett, 2013). Instead, they argue that the variability in human emotional experience and expression is far too variable to be explained by a limited set because basic emotions are not biological “natural kinds” but cultural conventions. According to constructionists, the evidence for basic emotions is severely lacking (Barrett et al., 2007; Lindquist, Wager, Kober, Bliss-Moreau, & Barrett, 2012), although their critiques have in turn been criticized for using unfair strawman arguments (e.g., Lench, Bench, & Flores, 2013). According to construction theories, emotions are constructed from core psychological principles via domain-general (i.e., not specific to only emotions) processes that take into account much more context than what basic emotion theories typically allow. The stimulus does not simply elicit an emotion; rather, the stimulus is actively (albeit typically unconsciously) attributed, contextualized, and conceptualized, which results in constructing a unique emotion according to myriad individual and (social and physical) contextual differences (Barrett, 2014; Russell, 2003). Emotion is therefore constructed, and each emotion is unique because it has been constructed to a unique situation. (See Cunningham, 2013, for the contemporary look at psychological constructivism; see also Mesquita & Boiger, 2014, for a social constructionist view.)

The current constructionist theories after Russell's (2003) core affect theory are often (but not always: see e.g., Mesquita & Boiger, 2014) also dimensional theories. Instead of attempting to explain how emotions are formed, the dimensional theories more practically aim to describe the structure of different emotions and of their relationship to each other. According to these theories, emotions do not differ from each other categorically, but rather in a matter of degrees along some central dimensions, typically valence (comprising pleasure-displeasure axis) and arousal (or bodily activation). For example, "happy" and "sad" can be located roughly at the opposite ends of the valence dimension, with roughly similar levels of arousal, while "afraid" and "relaxed" are opposite terms, in both, valence and arousal, dimensions (i.e., "afraid" in the sector corresponding with high arousal and negative valence, and "relaxed" in the sector corresponding with low arousal and positive valence, see Figure 3)[11]. The original emotional dimensions were obtained from research on subjective emotion reports that found that all the emotion words can be represented adequately by a circumplex formed around the two axes (Russell, 1980)[12]. Later research has found important psychophysiological signals linked to the dimensions, and the specific connection to motivational system, pleasure being related to approach and displeasure to avoidance motivation (P. J. Lang, 1995; Bradley, 2000). Sometimes, the alternate conception of somewhat independent Positive Activation and Negative Activation dimensions (Tellegen, Watson, & Clark, 1999) is also employed. This alternative organization presents the positive and negative activation as separate and relatively independent dimensions—that is, unlike the bipolar model, it acknowledges that people can have both positive and negative emotions at the same time (see Bradley, 2000).

[11] In addition, a third axis, dominance (sometimes called potency; Russell & Mehrabian, 1977), has been suggested, which would further differentiate between words representing discrete states such as "afraid" and "angry", both of which are otherwise associated with high arousal and negative valence in the two-dimensional model. Possibly because its explanatory power was much smaller to the valence and arousal axes, researchers have often settled on the simpler two-dimensional model.

[12] With predecessors, among others, already in Wundt's idea of six basic feelings that can be organized in three bipolar dimensions, in 1896 (see Reisenzein, 2000).

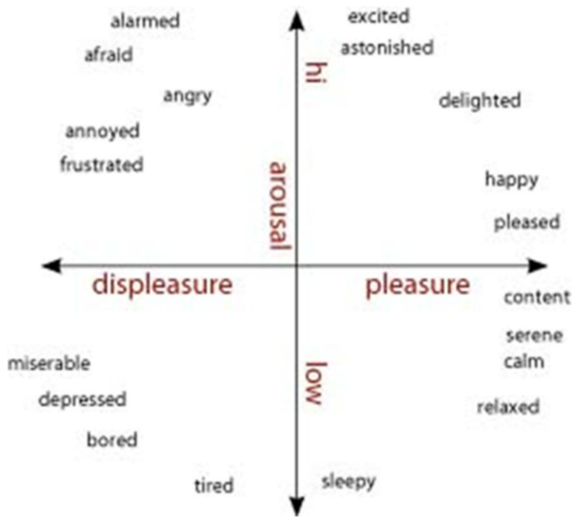

Figure 3. Valence – arousal dimensions showing self-reported emotion terms located around the circumplex, according to Russell (1980). https://commons.wikimedia.org/wiki/File:Valence-Arousal_Circumplex.jpg

While the basic emotion theories and constructionist theories offer rival understanding of how emotions form in a broad sense (and dimensional theories a rival description to basic emotions), most scholars regardless of theoretical orientation accept that the appraisal theories do capture something important about the emotion process: they zoom in to the specifics of how the mind must evaluate (appraise) the stimulus according to a set of criteria in order to produce the appropriate response. The premise is that evaluating the stimulus is likely divided into smaller problems so that each appraisal process evaluates a specific feature of the stimulus and determines between biologically predefined appraisal values (e.g., relevant/irrelevant to current goals). Interacting together, these appraisals define the emotion (for example, the instance of anger). Some theorists form systematic models to explain basic emotions (e.g., Roseman, 2013) while others attempt to describe the abstract and/or neural processes by which appraisals work (e.g., Scherer, 2009). (See Moors, Ellsworth, Scherer, & Frijda, 2013, for the contemporary look at appraisal theories.)

1.2.1.2. Emotion theories and games

To my knowledge, no study has empirically investigated the relative merits of different approaches on emotions in empirical game experience research (for the closest thing available, see Madeira, Arriaga, Adrião, Lopes, & Esteves, 2013), but something can be inferred from the choices the previous researchers have made, and from looking at the theories themselves.

Whether or not strictly true in all of their assumptions, the basic emotion theories have been found useful for many research questions in emotion research over the years (Lench, Flores, & Bench, 2011). What about the empirical game experience research? Very few researchers have used the basic emotions view in the digital game context (some examples include Merkx, Truong, & Neerincx, 2007; Liu, Agrawal, Sarkar, & Chen, 2009), and even when discrete emotional states have been studied, often the emotions chosen have diverted strongly from those typically listed by the basic emotion theorists, listing states like boredom, engagement, frustration, or fun (e.g., Chanel, Rebetez, Bétrancourt, & Pun, 2008; Mandryk & Atkins, 2007). To be fair, though, game researchers seem to have rarely familiarized themselves with current basic emotion research, which might be considered much more practical for game research purposes than the traditional collection of anger, fear, sadness, happiness, surprise, and disgust. For example, Panksepp's PLAY primary process (Panksepp, 2005) and the difference between affective and predatory aggression (Panksepp & Zellner, 2004) seem potentially useful for the game violence/aggression studies, as do Ekman's latest list of probable positive basic emotions for game experience research (including, e.g., sensory pleasures, excitement, and fiero; P. Ekman & Cordaro, 2011).

However, the issue is deeper than just finding the right list of emotions. While the basic emotion theories generally accept that other affective states than basic emotions do exist, they typically limit these other states outside their focus. During any activity, most of the time people experience some kind of continuous stream affective states of varying intensity, be they called emotions or not (cf. Cunningham, Dunfield, & Stillman, 2013; Zelenski & Larsen, 2000). Of these, basic emotions make up arguably only a very small part, as they are considered relatively rare and temporally short (P. Ekman, 1994); the basic emotion approach is not very useful for game research if it limits most of the game experience outside its focus. Indeed, first-hand reports of game experiences rarely report basic emotions (e.g., Sherry et al., 2006; Raney et al., 2006; Kallio et al., 2010), and it is unclear how the relevant affective states like fun, enjoyment, frustration, or boredom, are related to basic emotions. A committed research agenda would be needed to map the relationships between basic emotions and game emotions and the implications of such structures.

Although the details vary, the other theories have largely the same problem: their theoretical details are not easily applied to practical study, especially in the context of a complex stimulus like digital games. Constructionist theories allow (indeed, require) a vast variety of emotions, without the need to declare, for example, "fun" somehow less of an emotion than "happiness"—intuitively, a player of digital games can probably recognize experiencing fun, which is probably related to happiness but should not be equated with it—but the question is how can the constructionist theories be applied to the practical game research. Certainly, the constructionist accounts can inform the researchers and, for example, help understand how a game experience questionnaire should approach emotion terms (Clore & Ortony, 2013), but in many ways these theories operate on such an abstract level that they do not provide practical tools or predictions for the specific needs of game researchers. I am not aware of any game studies that would have used them.

Appraisal theories, mostly, do provide concrete empirical claims. Especially the component process model (CPM) by Scherer (2001, 2013) makes assertions about the nature and order of different appraisals which provide possible research directions for studying games. There have actually been some studies where the emotion theorists have used digital games to test the appraisal theory (e.g., van Reekum et al., 2004), but I have not seen game researchers using the theory for research purposes, although there are clearly opportunities. For example, the suggestion by Scherer (2013) that there are actually six different types of valence should be interesting for game experience theorists, for example in guiding the development of new experimental experience questionnaires. Similarly, the aggressiveness/violence research could be benefited by experimentally testing the goal conduciveness, coping potential, and norm compatibility stimulus evaluation checks to find out which kind of game situations cause which kind of appraisals that end up in anger and aggressiveness, and compare that to the current assumptions of how games might be associated with violence (Markey & Markey, 2010; see also: C. J. Ferguson, 2007).

To my knowledge, the dimensional valence-arousal model seems to be the only emotion-theoretic contribution that has been utilized in the game research field to any meaningful extent. Following the general psychophysiological research, the psychophysiological game research has routinely interpreted the physiological measures as indices of the emotional dimensions (e.g., Mandryk & Atkins, 2007; Drachen, Nacke, Yannakakis, & Pedersen, 2010; Poels, van den Hoogen, IJsselsteijn, & de Kort, 2012). However, it has been typical that these studies have taken the dimensional model as granted, without considering the theoretical background properly and without discussing the limitations of the measurements as such indices[13]. For instance, in one of the core articles on this, Lang (1995) claims that the emotion and motivation can be conceptualized as two dimensions of valence and arousal, but his argument for that claim is the motivational system is an evolutionary adaptation and that certain stimuli—particularly those related to personal well-being—are hard-wired to activate that system. This is not trivially applied to a radically different context, such as digital games. In fact, Lang specifically mentions that his evidence pertains to "states of vigilance, when the organism is stopped but actively orienting", of which the picture viewing is a quintessential example (P. J. Lang, 1995, p. 382)—and a notable deviation from a game context. Although later, Ravaja (2004) reviews several reports of successful use of the method in other contexts, such as sounds and moving picture, they still adhere to that basic assumption. Neglecting these assumptions and extending the justification to vastly different context is potentially dangerous, as it misinforms the readers about the relationship of the measure and the theoretical concept.

Next, I briefly present the methods of measuring emotions, specifically focusing on the measures used in game research studies and their known limitations, and describe the relationship between measurements and the theoretical concepts they profess to index.

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[13] And by "typical", I also refer to my own publications.

1.2.2. Measuring emotions

Because of the disagreement of the theoretical basis of emotion, it might expected that the same disagreement extends to measurements as well. In contrast, the researchers are relatively same-minded about them, mainly due to the agreement of the emotion components which manifest the emotions—whatever their form and operation—to the outside world. As emotions are seen as multicomponent phenomena, there is no single sufficient method for measuring "the emotions" directly; instead, one must measure the components, which can then be used to infer something about the psychology behind them. Peter Lang (2014, p. 96) states about measuring emotions: "[T]here are three measurement domains available to a science of emotion: affective language (evaluative and expressive), overt behavior, and physiological reactivity." A review on measures of emotion by Mauss and Robinson (2009) largely agrees.

Affective language covers everything from text analyses (related to the expressive and perhaps to the behavioral component) to introspective self-assessment in an interview or in response to pre-made questionnaires (related to the subjective feeling and expressive components). Physiological reactivity, related mostly[14] to the physiological component, covers measurements as diverse as direct signal measurements (such as skin conductance), measurements of indices calculated from simpler signals (from number of skin conductance responses to complicated indices of heart rate variability and electroencephalographic frequency analyses), measurements taken during a specific research paradigm (such as the startle eyeblink magnitude), and complicated imaging techniques (such as functional magnetic resonance imaging of the brain).

In the context of this dissertation, with the focus on a clearly bounded, relatively short play situation, I consider only self-report questionnaires among the measurements of affective language, and mainly direct signals and some

[14] Although Mauss and Robinson (2009) count facial activity as a behavioral measure, I consider it among physiological measurements, because in the context of this dissertation it is measured directly from the muscles and not assessed from observations. As Bradley (2000) states, the physiological and behavioral components have a particularly close link due to the fact that behavior cannot occur without some physiological changes.

indices calculated from them among the physiological signals. Further, I do not discuss observational assessments of behavior.

1.2.2.1. Self-reports

The often-used self-report measures of emotion include questionnaires based on the dimensional theories, such as the pictorial Self-Assessment Manikins (SAM; Bradley & Lang, 1994) and various grid-forms of the valence and arousal dimensions (validated, e.g., Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009; or ad hoc measures such as in Merkx et al., 2007) or PANAS, which is based on the hierarchical model of emotions and therefore also covers discrete emotions (Watson, Clark, & Tellegen, 1988). In addition to theoretically justified questionnaires, game researchers have studied subjective emotional experiences by using single ad hoc items (e.g., "How much did you enjoy the game session?"; Merritt et al., 2011), or items as part of other constructs such as flow (e.g., Takatalo, Häkkinen, Kaistinen, & Nyman, 2010).

However, while it is too often simply taken as granted that the self-reports reliably convey what the individual has subjective experienced, the potential for biases and distortions in self-report measures is well documented. First, the meaning of words (or images) by which the self-report item or an interview question is conveyed is not obvious or universal, and the simple semantic structure of the sentence may have a significant influence on the responses (Ahlawat, 1985). While there are attempts to prove particular words as more valid as descriptors of emotion, the results are contradictory, and raise questions about the influence of the pre-existing theoretical leaning of the researchers (see e.g., Fontaine, Scherer, Roesch, & Ellsworth, 2007; versus Yik, Russell, & Steiger, 2011). In addition, the used words guide the interpretation, such as the reconstruction of a previous experience (in the context of judicial use of eyewitness evidence, see Innocence Project, 2009); simply the choice of particular words in the question will lead the respondent to think about the experience in regard to those particular concepts, regardless of whether they would have been the concepts the respondents would have used themselves (Slater, 2004). Second, the memory is not a perfect reproduction of the experience, and the memory is decayed more and more with the passage of time: for example Robinson and Clore (2002) concluded that self-reports of one's current experience ("online") are likely to be more valid than self-reports concerning past, future, or trait-related experiences of emotion. Furthermore, situation-specific and identity-related beliefs are processed differently, and retained social stereotypes and personality traits all influence how we see the target of the inquiry, and thus the responses (Robinson & Clore, 2002). Third, there are several effects that further affect the response, such as social desirability effect (Paulhus & Reid, 1991), and the simple case that sometimes the respondent does not want to answer completely (or at all) truthfully (Krumpal, 2011). In addition, the influence of each of these sources potentially varies culturally, between individuals, and between different situations.

1.2.2.2. Physiological measurements

The physiological measurements tap into the bodily responses that are under the influence of autonomic and somatic nervous system. Unlike self-report measures, physiological measures are not affected by memory, question formulation, or social desirability, so some researchers have considered them as more objective than self-report measures (e.g., Mandryk, Atkins, & Inkpen, 2006). Objectively, they do have the advantage to be able to give information on processes that self-reports have no possibility to tap: online measurements of continuous signals that give a view on the emotion process as it happens, and the temporal resolution that allows examination of momentary changes (phasic data in addition to tonic), for example, in response to individual interesting events.

The psychophysiological measures are typically used within the dimensional emotion approach (e.g., Mandryk & Atkins, 2007; Nacke, Grimshaw, & Lindley, 2010). Briefly, facial electromyogram (EMG) activity in zygomaticus major and orbicularis oculi (ZM and OO, activated when smiling) muscles is considered a good index for positive valence, and activity from corrugator supercilii muscle (CS, activated when frowning) for negative valence (Tassinary & Cacioppo, 2000; P. J. Lang, 1995). Electrodermal activity (EDA) is a widely used measure for assessing arousal (P. J. Lang, 1995; Dawson, Schell, & Filion, 2000). Heart rate is often used to index arousal, although this may be suspect in many cases, because the heart responds so broadly to all kinds of changes, not only arousal (Ravaja, 2004; Brownley, Hurwitz, & Schneiderman, 2000). Other measures, such as respiration as another measure of arousal (Ravaja, 2004), are also sometimes used. In addition, electroencephalography (EEG), the only relatively cheap method of studying brain activity (in contrast with the massive prices of brain imaging techniques like fMRI) can be used to examine a wide variety of phenomena (Davidson, Jackson, & Larson, 2000), but in regard to emotion research, the specifically useful measure is the frontal asymmetry: the activation difference between frontal lobes related to approach-avoidance motivation, which is closely linked to emotion (Salminen, Kivikangas, Ravaja, & Kallinen, 2009; P. J. Lang, 1995).

Like data originating from self-report measures, however, physiological measures are still far from being direct measures of emotion. They are subject to their own range of external influences, such as movement artifacts and technical difficulties. In addition, just as with self-reports, physiological data must be interpreted to make inferences about emotions, and due to the complexity of human physiology, especially in a complex stimulus context, this is not exactly straightforward (Ravaja, 2004).

1.2.3. Making inferences based on measurements

Although too often the measures are used as if they had almost direct relationship to the emotion dimensions, it is forgotten that in reality the relationship is complicated—that measures do not tell much themselves, but that they are used for making inferences (see Figure 4). As Cacioppo and others (2000b) stress in the introductory chapter of *Handbook of Psychophysiology*[15], in a given context, only some of the signals are related to the hypothesized underlying psychological (emotional) processes, and then only in part (Cacioppo et al., 2000b)—and of course the same applies to self-reports. That the relationship between the two is relatively distant is demonstrated by the rather low correspondence between physiological and self-report measures: it is actually rather an exception than a rule when the two neatly converge (covariations around ten to twenty percent of the variance across the response

[15] They talk about psychophysiological measures, but the point can be extended to all measures.

systems have been mentioned as typical; Bradley & Lang, 2000; see also Mauss & Robinson, 2009; Russell, 2009; Barrett, 2013). This does not mean that the two are unrelated. Both are imperfect signals of the individual components only partly reflecting the underlying emotional processes, contaminated with non-relevant processes and noise. Because both have their own flawed view to the emotional processes that are the real target of the measurements, both are also needed. However, in general psychophysiology, the work about the validity of psychophysiological measures is still slowly proceeding about the very basic contexts and processes: perception, imagination, and anticipation, while the action is still relatively untouched (Bradley & Lang, 2007). This means that in the field of game research, where the stimulus is much more challenging for making solid inferences, we should be especially careful in using our methods properly.

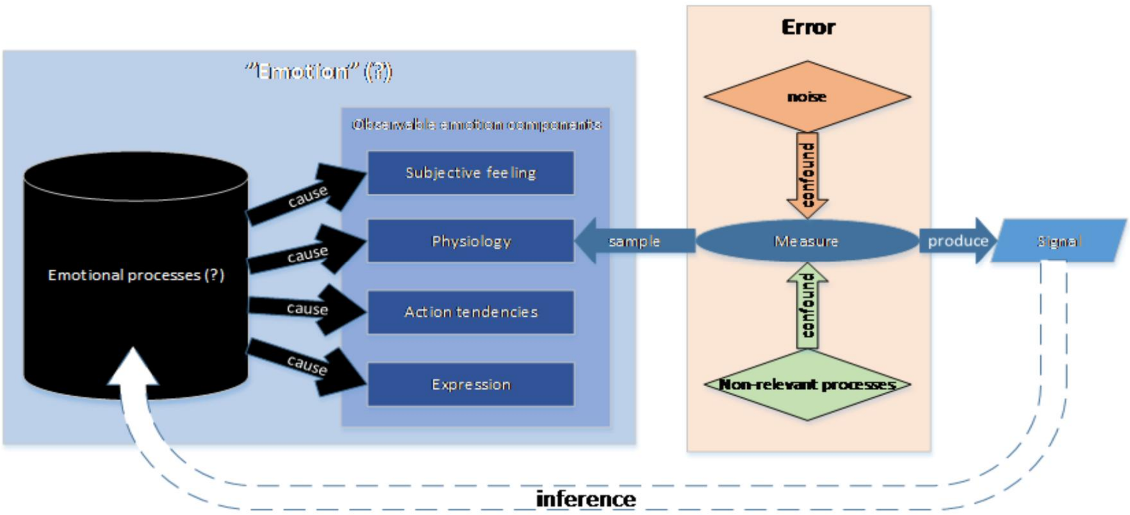

Figure 4. The process of measuring emotion. We want to find out something about the emotional processes (which we are not entirely sure of what they exactly are), for example, the theoretical construct "arousal". The processes cause observable emotion components, which can be sampled by the measure. The measure, however, is also confounded by non-relevant processes and noise, introducing error to the measure. We detect the signal produced by the measure, which we analyze statistically to infer something about the emotional processes.

1.3. Aims of the study

As stated in the beginning, this work has two approaches that rely on each other. The critical approach builds on the theoretical contributions to frame the measures and their interpretation within the existing research literature. The empirical approach uses the measures to present novel empirical results about the emotions experienced during social game play. The discussion integrates these approaches and offers new understanding of the social context of digital game play and how it relates to emotions. Table 1 summarizes the Studies and their foci.

Table 1. Summary of the articles and the four experiments.

Study	*Nature of study*	*Study focus*
Study I	Review	A review of psychophysiological measurements and how they have been used in game research (in 2011)
Study II	Theoretical	A proposed model for interpreting results about emotions
Study III	Experiment 1	Phasic event-related physiological responses to different opponents
Study IV	Experiment 2	Tonic physiology and self-reports during competitive and cooperative play (binary), different genders, different locations
	Experiment 3	Tonic physiology and self-reports during competitive and cooperative play (four conditions), different genders
Study V	Experiment 4	How tonic physiology and self-reports predict actual play and preferences

Study I (Kivikangas et al., 2011) is a review on psychophysiological measures used in game research, on which I base the overview on how game research literature have relied on emotional theories as their justification for the measures. Then, Study II (Kivikangas, in press) presents my own synthesis of emotion theories, which offers a novel view on the emotional processing. In this dissertation, I use these two studies to take a critical look at the measurements of emotion in digital game research, with the aim to find a more comprehensive and, hopefully, a more accurate view on what measuring emotion is and can be. Because the empirical studies were conducted before this work, they have still used the old paradigms, but in the discussion, my aim is to apply this new knowledge to reinterpret the results where applicable.

Looking at the empirical results on the context factors as they are presented in the previous section, certain factors seem more important than others: the type of presence of others and the role of participants, and the relationship between participants, their gender, and the play environment. Each has empirical evidence, ranging from convincing to tentative, for its significance, but each also has important shortcomings to which this dissertation aims to offer new insight.

First, the evidence both from physiological and self-report data on two questions, the influence of type of presence of others, and the influence of the relationship between the players, is rather strong: the experience is more positive when played with a human, and less positive when played with a virtual co-player (computer AI); and likely also more positive when played with a friend vs. with a stranger. But almost all the studies have been tonic in nature (i.e., studying aggregate signals over the whole experience). The only exception, studies by Mandryk and others (Mandryk, Inkpen, et al., 2006; Mandryk & Atkins, 2007) that report time series data, were focused on the methodology and did not analyze differences in phasic responsivity to the different types of presence (local vs. virtual). That information is important for practical purposes, for example when designing adaptive systems that react to the changes in a user's emotional state, but also when trying to understand the mechanisms under which the game experience work. Study III (Kivikangas & Ravaja, 2013), reporting Experiment 1, offers experimental data on the different responses to events of victory and defeat—arguably the constitutive events regarding any multiplayer game set up as a competition (cf. Salen & Zimmerman, 2004)—when the opponent is a friend, a stranger, or an AI.

In addition to competitive games, there are cooperative games. Research shows that competitive games are reported usually (but not always) more positively. However, the only psychophysiological study (using only measures of arousal) on the topic used rather contrived experimental conditions that raise the question of ecological validity (a single encounter of trading or dueling within a MMO game; Lim & Reeves, 2010). As the second empirical contribution, Study IV (Kivikangas, Kätsyri, Järvelä, & Ravaja, 2014) reporting results from two experiments, Experiments 2 and 3, investigates the self-reported and physiological effects of the player roles (competitive or cooperative), and furthermore, their interaction with the gender, as it appears to be of some significance. In addition, the effect of location is examined in Experiment 2, and the comparison between local and virtual co-presence in Experiment 3.

The third empirical contribution, Study V (Kivikangas, Järvelä, & Ravaja, 2015), reporting Experiment 4, shows the practical significance of the self-reported and psychophysiological measurements in game context: their predictive power in regard to future play and preferences. It is all good in the academic world to find statistical differences between conditions, but for the first time, there is also practical information on what they mean in the real world.

2. Methods

2.1. Theoretical contributions

2.1.1. Review of psychophysiological methods in game research (Study I)

The original work that Study I is based on was done in 2010, for a Digital Games Research Association conference (DiGRA Nordic, August 16-17, 2010, Stockholm, Sweden; Kivikangas et al., 2010), from which the best papers were invited to be published in the special issue in Journal of Gaming and Virtual Worlds. The searches (see below) were redone in 2011 to include any new articles on the topic of the manuscript that eventually became Study I. Because both of the articles were limited to a word count set by publisher, the review was not exhaustive or systematic.

Study I gives a quick overview of the contemporary understanding of the theory that the psychophysiological measurements were based on at the time, and the practical use of the methods. The most important source was the Handbook of Psychophysiology, 2nd edition (Cacioppo, Tassinary, & Berntson, 2000a), with the chapter on emotion and motivation (Bradley, 2000) as the main theoretical framework. The other major source was the review of psychophysiological methods specifically in the context of media research (including TV, newspaper, non-game computer use, and so on; Ravaja, 2004), which provided further interpretation and recommendations of the use of methods with more complex stimuli. Other measures than the ones used in this dissertation (electromyography or EMG, electrodermal activity or EDA, and heart rate or HR) were also overviewed, especially electroencephalography (EEG).

Reviewing the empirical studies using psychophysiological measures in game research, the articles were searched[16] with Google Scholar by keyword “(digital or video or computer or electronic) game(s)” with one of the following keywords: “psychophysiology” or “psychophysiological”, or measure-specific keywords such as “EMG” (or “electromyography”), “EDA” (or “electrodermal activity”) or “SCL” (or “skin conductance level”), or “HR” (or “heart rate”). The

[16] Unfortunately, the exact search terms or the search methods are not reported in the article, so this is based on my, probably flawed, personal recollection. See limitations, section 4.2.

resulting hits were further cleaned from articles that did not specifically study digital games but, for instance, used a digital game to elicit stress during a general psychological experiment. The remaining articles were classified according to their apparent purpose, to validity studies, social game experience studies, studies about game features, studies about game events, studies about the long-term game effects on the player, and studies using psychophysiology in game design (or rather, development). Long-term game effects are only lightly touched, as mostly those studies have a clearly different aim (finding out about the negative effects of game violence, or about the positive effects, such as learning) than the rest (how is the player affected at the moment of playing, and its practicalities).

2.1.2. Theory development (Study II)

In Autumn 2014, during a personal grant for finishing this dissertation, I was frustrated with the weak theoretical basis I had for emotions and their relationship with the psychophysiological measurements. I began rereading the emotion-theoretical literature I was already familiar with, but I quickly turned to look for more recent studies. After looking for an integrated overview in the chapters in *Handbook of Emotions* (Lewis, Haviland-Jones, & Barrett, 2008) to no avail, I found the journal *Emotion Review* (http://emr.sagepub.com/) and its long, edited special sections on various topics within the field of emotion research by the most established current authors. Specifically the issue 2014, 6(4), entitled Four Perspectives on the Psychology of Emotion (Russell, 2014a), confirmed that while there is no integrated theory of emotion, there are important commonalities (Russell, 2014b); and while there are clear differences, the problem (of the field) seems in many cases to be more in the assumption of generality (i.e., that a specific theory is a general theory of emotion, and not a theory about a specific part of the whole) than in “correctness” of these theories (Nesse, 2014). Reading the special sections on basic emotion theories (Russell et al., 2011), constructionist theories (Cunningham, 2013), and appraisal theories (Moors et al., 2013), and the current work of the dimensional theorists (Norman et al., 2011; P. J. Lang, 2014) helped me to conceptualize the current knowledge along the four main theory families—as well as to understand exactly what is the focus of these theory families and how they might relate to each other.

In the end, the neuroscience of Panksepp (Panksepp & Watt, 2011) and LeDoux (2014, 2012) convinced me of the basic neural circuitries that drive very specific behavior changes in animals. Scherer's (2013, 2009, 2001) suggestion of a fixed order of appraisals—that must be somehow part of these neural circuitries—made me realize that what is currently missing on the neuroscientific side is the structure of how the "primary processes" (Panksepp's preferred term for what others call basic emotions) relate to each other: if appraisals launch primary processes, then some primary processes are quicker and less complicated (in terms of required processing) than others. When this insight was combined with the constructionist critique from Russell (2003, 2009), it seems evident that the "hundred-year war" between constructionism and basic emotions (Barrett, 2013; Lench et al., 2013) is about focus (and generalizing the results of one's own focus to the whole system): the universal and automatic basic emotions and the variable, constructed emotions can coexist, when the former are understood as the quick responses to evolutionarily salient stimuli, and the latter as the later, more thoroughly processed (conceptualized, contextualized, and culturally affected) constructions. Finally, I found that LeDoux's "global organismic states" and Russell's (2003) core affect are connected with the Evaluative Space Model (Norman et al., 2011), which models the primary modes of emotional valence and motivation—positivity/approach and negativity/avoid—that affect the emotional processing on different physiological levels. Other, minor, influences were the evolutionary approach by Tooby and Cosmides (2008) and Tracy (2014), the neural view by Cunningham and others (2013), the case for modular mind by Kurzban (2010), and the experiments for finding consciousness by Dehaene (2014).

Study II (Kivikangas, in press) gives an overview to my synthesis of these emotion theories. The detailed account of the connections between the theories, the assumptions needed for the integration, and the implications could not fit that manuscript nor this one, and are left for later publication (Kivikangas, n.d.).

2.2. Empirical contributions

2.2.1. Participants

Participants in all the experiments were young (age ranging from 18 to 34, mean around 23 or 24) volunteers recruited by university mailing lists and (except in Experiment 1) by advertisements on discussion forums of popular gaming magazines in Finland. All participants were ethnic Finns and spoke Finnish as their native language. To reduce the effects from differences in previous experience and to ensure sufficient skills for all the participants to play the game, each experiment was designed for participants already familiar with gaming and the employed game genres, and in Study IV experiments, also the particular games used, so suitable previous experience was a selection criterion for the participants. This requirement also inadvertently affected the gender balance of the participants in the both Study IV experiments, as the volunteers were typically overwhelmingly male, and to obtain enough female participants the recruitment emails had to be resent several times. Table 2 summarizes the participants of the four experiments.

In Experiment 1 the research question—the effect of relationship to the opponent, a friend or a stranger—was examined by employing participants in groups of three same-gendered persons. Two of them were self-declared friends (they were recruited together) and one was a person unknown to the others (i.e., a stranger, ensured from the other two before the experiment was started). One

Table 2. Summary of participants in the four experiments.

Experiment	*n*	*Male/ female*	*Experiment type*	*Notes*
Experiment 1 (Study III)	33 (99)	17/16	single measured (dyad playing)	one participant chosen as the main participant whose responses were measured, who played against the other two, separately
Experiment 2 (Study IV)	48	30/18	dyad	
Experiment 3 (Study IV)	82	50/32	dyad	
Experiment 4 (Study V)	36	36/0	single	all-male sample

of the two friends was randomly chosen as the main participant, and only this main participant's physiological signals were recorded in the experiment.

In both Study IV experiments the participants were recruited in same-gender dyads. Cross-gender dyads (and cross-gender triads in Study I) were left out in purpose, because with already small samples the statistical power would have decreased to untenable level. The dyads volunteered together, so the participants in each dyad knew each other before the experiment.

The nature of Study V, a follow-up study to make predictions about future behavior and responses, did not require dyadic data, so participants were recruited individually. Only males were employed, because based on previous experiments, males were easier to recruit, and it was assumed that as the three-week follow-up period would be more demanding than sole laboratory experiments, it would be difficult to obtain sufficiently balanced samples of both males and females.

2.2.2. Stimulus games and game-specific arrangements

As the digital game experience, including the emotions, is not solely a product of the outcome of the game (i.e., win or loss), but also the rules of the game—concretized in how the "game world" works and how the player can access and manipulate it—and its audiovisual output, it is important to understand the rudimentary facts about these in regard to games used in the experiments.

2.2.2.1. Experiment 1 (Study III)

The stimulus was a simple FPS game Duke Nukem Advance—an acclaimed game on the GameBoy Advance hand console still popular at the time of conducting the experiment. The game parodies action movies of the eighties with crude cartoonish graphics and sounds. Both two-player and single-player modes were played from the beginning of a predefined game map and continued until eight minutes had passed, at which point the experimenter asked the participant to pause the game and answer the questionnaires. The two-player and single-player modes were not identical: whereas the two-player game was played in a maze-like map where the only characters are the PCs and the purpose is hunt down the other PC (depicted as a stereotypical muscular action hero), the single-player mode employs a story mode with (the little) narrative running in text boxes and the less contrived map containing dozens of opposing NPCs (depicted as anthropomorphic animals) on the way to the exit. The friend and stranger conditions differed from each other only in respect to who was playing the other PC. The participants played the game side by side, so the players could communicate with each other—however, a separate study suggested that co-location did not change the results in respect to non-co-location (Ravaja, 2009).

The victory and defeat events were the same in two-player and single-player modes: in victory, the opposing character collapses with a (cartoonish) blood splatter and a scream when shot, and in defeat the screen goes red with a groan and a text indicates that the player has lost, until the game resumes after a small pause. The main differences between the modes were that there could be, and often were, several NPCs in the same room at the same time, while this was never possible in the two-player mode, but on the other hand that the AI was much less difficult opponent than a human player. Due to these differences, Study III does not make direct comparisons between the modes.

2.2.2.2. Experiment 2 (Study IV)

Experiment 2 employed a remake of a popular cartoonish arcade game, Bomberman, on the PSP hand console. There are two to four characters in the game, and we arranged four characters in teams of two. The goal of the game is to eliminate characters belonging to opposing teams by moving in a small abstract board, shown in its entirety, and drop bombs that explode after a small delay, clearing the blocks and blasting out any characters (including the PC that dropped the bomb) the explosion hits. One match normally takes from two to five minutes. Within the eight-minute limit in our experiment the participants had time to play from one to three matches.

The cooperative and competitive conditions were identical in respect to how the game worked—the only difference was that the team arrangement was two human players against two AI characters in cooperative, and each human player with one AI character against the other team with the other human player and one AI character in competitive condition. The AI in this game was not easily distinguishable from human players due to the simple and abstract dynamics of the game, and could be even considered to be at the level of an experienced player.

2.2.2.3. Experiment 3 (Study IV)

We had suspicions that the hectic action in the Experiment 2 game may have masked some arousal effects, and that the game may have been more accessible to males than to females. In addition, we wanted to include a separate condition for a mix of competition and cooperation, and to control better the victories and losses of the participants (that could not be easily recorded during Experiment 2), so the game was changed for the second experiment. Experiment 3 used a simple abstract game, HedgeWars, which is an open-source clone of a popular commercial game Worms (or more specifically, its sequel, Worms Armageddon). The game is a cartoonish turn-based artillery game, where game characters start from random locations in a landscape viewed from the side, and the goal is to shoot opposing teams with ballistic weapons, either to blast them to the water surrounding the landmass (which is also destroyed by each explosion), or by decreasing their life points to zero with subsequent shots. Each player controlled three characters, one per turn, and the (randomly ordered) conditions determined the team arrangements. (1) In cooperation, the participants played in the same team against an AI team (similar to competition in Experiment 1). (2) In mixed cooperation and competition, the participants played in the same team against an AI team, but at the same time they competed within the team for higher score. (3) In competition, the participants were in different teams with one AI “player” that had three characters (similar to competition in Experiment 1). Finally, to investigate the effect of AI presence, (4) competition without computer was a condition where the participants played in different teams without the AI characters. There was no other difference in how the game works. However, because the decisions made in HedgeWars are much more complex than those made in Bomberman, the AI characters’ behavior was markedly different from behavior by characters controlled by human players.

2.2.2.4. Experiment 4 (Study V)

We used four different games, but the experimental conditions did not change within games, but between them, to find how the different emotional experiences predicted future play and preferences. The chosen games all had good Metacritic averages (http://www.metacritic.com, a site aggregating game reviews from game journalists), but they were a bit older, to avoid limiting potential participants with demanding technical requirements (as the games were meant to run also on the participants' own computers) and to avoid the potential confounding effect of marketing campaigns. We used two games from two popular genres, first-person shooters and adventure games. The FPSs were Painkiller, a quick-paced unrealistic old-school shooter with vast masses of enemies and powerful weapons, and Operation Flashpoint: Cold War Crisis, a more realistic infantry soldier simulation. The adventure games were Fahrenheit (known as Indigo Prophecy in the US), a cinematic supernatural thriller with intense action sequences, and Sam and Max: Season One, a slow-paced comedic point-and-click adventure. In addition, in order to introduce variability between the games despite their roughly equal quality, the aim was to choose one to be more "light-hearted" (PK and SM) and one a more "hard-core" (OF and FA) within the genre, although without any objective measure, this was ultimately based on authors' personal judgment.

2.2.3. Procedures and experimental conditions

Table 3 summarizes the examined factors and dependent measures in the four experiments.

The procedures in all experiments followed the same basic steps. Beforehand, the participants were asked to answer trait and background questionnaires. The laboratory session began when the participants were brought in the observation room outside the laboratory, and the participants were briefed on the purpose of the particular experiment to the extent that did not reveal the exact focus—i.e., it was explained that the physiological measures are associated with emotions, but it was not explicated which parts of the stimulus we expected to be related to the changes in those emotions. The participants filled informed consent forms, after which the participants were seated in the laboratory that was set up for

Table 3. Summary of examined factors and dependent measures in the four experiments.

Experiment	Examined factors and their levels	Dependent measures
Experiment 1 (Study III)	Relationship to opponent: friend, stranger, AI (Presence of AI opponent: yes, no)	Physiological emotional responses
Experiment 2 (Study IV)	Mode: competition, cooperation Gender: female, male Location: laboratory, home	Physiological and self-reported emotional responses
Experiment 3 (Study IV)	Mode: competition, cooperation, mixed Gender: female, male Presence of AI opponent: yes, no	Physiological and self-reported emotional responses
Experiment 4 (Study V)	Physiological and self-reported emotional responses *	Play time & preferences

Note. * Emotional responses were not a categorical factor, but were instead modeled individually as linear effects.

comfortable game play. The electrodes were attached, the signals were tested, and (except in Experiment 4) it was ensured that the participants knew the controls and could play the game during short a practice session. Then, a brief rest period (five to eight minutes) calmed the participants before the experimental phase that contained the conditions detailed below. Finally, after the experimental phase and while and after the electrodes were detached, the participants were offered an opportunity to ask questions that could not be asked beforehand, and when they were finished they were thanked and compensated with movie tickets. In case of Experiment 4, the participants also received some of the games employed in the experiment after the three weeks of follow-up phase.

Study III investigated the effect of external social context on phasic emotional responses to important game events. The external social context was manipulated as the relationship between the players, and for this, the main participant played the game in three 8-min conditions: once against the friend, once against the stranger, and once against computer-controlled characters only (in the single-player mode), in randomized order, with physiological measures taken during the play and self-reports afterwards. The game play was video recorded, and afterwards manually viewed and scored to pinpoint the important events, victory (shooting the opponent character) and defeat (the PC getting shot) events, within the data. As many of the events occurred so close to each other that the events overlapped, only non-overlapping events were used to ensure that the responses were not contaminated. However, data from overlapping were compared to see if the overlapping events were very different from the non-overlapping ones; they were not.

Study IV investigated the effect of both internal and external social contexts in both experiments. The internal context was the extent of cooperativeness/competitiveness (mode), and the external context was the gender of the players. Experiment 2 was set up as 2×2×2 design, which, in addition to the mode (within-subject) and gender (between-subjects), controlled another external context, the location (home or lab as a within-subject factor), to find out whether the laboratory could be considered as an ecologically valid measurement site. Each of the four within-subject conditions lasted again for eight minutes after which the play was terminated. Experiment 3 repeated the mode and gender factors (and removed the location factor), and added two new conditions: one to test the mixed mode where the participants simultaneously cooperated between each other while competing against the computer-controlled characters, and another to control the effect of computer-controlled characters by removing them altogether for a comparison. The conditions were of variable length (from less than five to almost twenty minutes), as they lasted for one match in the game, naturally varying. In both experiments physiological measures were recorded during the play, and self-reports were collected after each condition.

Study V switched the focus to finding out how the emotional responses, the dependent measures in all the other experiments, are related to actual play behavior afterwards, namely play time and preferences. The participants played four different games in four conditions, half an hour each, after which they freely chose any of the four games to play for another hour (they also could change the game as they pleased; some participants did change the game once, and nobody did it more than once). Once again, physiological measures were taken during the play, and self-reports after each condition. After the laboratory session, the participants were given the four games with them along with custom-made software, and they could play the games in the following three weeks follow-up phase as they wanted while the software recorded the play times. Finally, after three weeks, the participants answered questions of preference.

2.2.4. Measures

2.2.4.1. Physiological measures

All experiments employed the same physiological measures that have been commonly used to (ostensibly) index emotions within valence-arousal framework. See discussion in section 3.1.

Facial EMG activity was recorded with surface electrodes from the left CS, ZM, and OO muscle regions, as instructed by Tassinary and Cacioppo (2000). EDA was recorded from the ring and little fingers of the participant's nondominant hand (Dawson et al., 2000); the fingers were chosen—instead of the typical index and middle fingers—because they are not used when the participant is playing a digital game with a game console or a personal computer. ECG was also recorded (although not reported in Study V) primarily to extract the heart rate. In addition, Experiment 2 reported results from accelerometers located on chest and on the backside of the game console (used also in Experiment 3, but discarded due to technical difficulties), representing how much the participants moved themselves and how much they moved their hands holding the game console during the game.

2.2.4.2. Self-report measures

All four experiments used self-report questionnaires, and the most important ones of these were same in them all (see below); however, as the tonic responses to the Experiment 1 were already reported elsewhere (Ravaja, Saari, Turpeinen, et al., 2006), the self-reports—that are tonic by their nature—were not reported again in Study I. Therefore the self-reports of the Experiments 2 thru 4 are listed here.

Emotion questionnaires common to rest of the three experiments were Self-Assessment Manikins, providing an assessment of valence and arousal on separate scales that present simple pictures of smiling/frowning faces and active bodies without verbal descriptions (P. J. Lang, 1980). Parts of the PANAS-X (Watson et al., 1988), a likert-scale verbal questionnaire for discrete emotions and more general positive and negative affect, were used in both Study IV experiments.

In addition to emotion questionnaires, Study IV experiments employed a social presence questionnaire SPGQ (de Kort et al., 2007), and several other less relevant questionnaires and individual items.

2.2.5. Analyses

Due to limitations set by the vast individual differences in physiological activity levels and reactivity, psychophysiological experiments are commonly designed as within-subject comparisons. This also places demands on the statistical analyses, as the common ANOVAs cannot be used for repeated and multilevel data that may also feature strong autocorrelations. Linear Mixed Models (LMMs) that have the additional benefits of robustness to non-normally distributed and randomly missing data—both important features when analyzing physiological data—were used instead.

LMM is an extension of simple linear regression, with the ability to model individual intercept and slope for each predictor variable, and with an in-built account of the variance structures such as autocorrelation. After the predictor and outcome variables have been processed and, as often is case with physiological data, transformed to more normally distributed form, the data is restructured into format where one row of data represents one data point (tonic or phasic average), and the multilevel structure—which condition and participant the data point is from—is identified with separate identifying variables. LMM, as used in my studies and run in SPSS software, then needs the repeated effect defined in terms of these identifying variables: typically this is a product of participant and the condition numbered in the order it actually occurred in the experiment, with the first-order autocorrelation covariance structure defined for residuals (i.e., assumes that data points from one participant are correlated the more the closer they are to each other, in a certain formula).

3. Results

3.1. Studies I & II

3.1.1. The current state (Study I)

Study I presents a review of psychophysiological methods in game research (in 2011 and earlier), their typical theoretical framework, and empirical studies and results gained using said methods. Although the review, with its shortcomings, was not exhaustive of all the published game studies using psychophysiology until 2011, I assume that the articles included in the review are a representative sample of such studies, and therefore can tell us about the general tendencies in the field.

First, what can we say about the evidence for using psychophysiological measures in game research? Looking at the first category, Study I lists 14 articles among the so-called validity studies. Although they all report pioneering experiments that attempt to find out how psychophysiological measures can be used in the context of digital games, they also wildly vary in the purpose (creating automatic emotional adaptation or emotion classification systems, empirical testing of hypotheses, methodological development), in measures they use (EMG, EDA, cardiac measures, EEG, eye-tracking, fMRI, accelerometer, controller pressure, respiration), and in games they use as a platform (from custom created virtual environments to off-the-shelf games of sports, racing, learning puzzle, survival horror, and children's physical games, among others). There is no building on the results of previous studies in a systematic manner, so the evidence for validity relies on a rather random assortment of studies that happen to conclude that the method is sound (also raising the concern about the potential for publication bias; see Simmons, Nelson, & Simonsohn, 2011; Ioannidis, 2005). It is not clear at all what we are actually measuring with these measures, in this context.

Extending the scrutiny to other categories, it seems that the studies on social game experience (as reviewed in section 1.1.2) and on immediate effects of game events (and perhaps the effects of game audio) have several different researchers focused on a rather limited set of factors building on previous results. The convergence of these results makes it more likely that they are reliable, while the studies on methodology ("validity") and game features seem more isolated. (In addition, several studies creating categorization algorithms for emotions, or dynamic adaptive difficulty systems, are reported and might show a good consistency, but I am not expert on these topics.)

How about the theoretical basis regarding emotions? How much do the authors appeal to theoretical justifications? Twenty-six of the reviewed articles described some kind of an experimental study of an emotional experience (I ignore the articles cited in the game effects and game design sections here, as they clearly had different aims). Of those 26 articles, ten did not refer to any emotional theoretical framework on which its view on emotion was based, using terms like "emotion", "arousal", "fun", "frustration", and "positive affect" without explaining them[17]. Among the sixteen remaining articles (including several by my colleagues and me), a few (e.g., Mandryk & Atkins, 2007; Ravaja, Saari, Turpeinen, et al., 2006; Lim & Reeves, 2010) briefly considered the theoretical limitations of making inferences about emotions from physiological data, but mostly the articles took the relationship between physiology and emotion more or less for granted. Although the wordings in the articles (such as "is associated with") never imply a 100% correspondence, the lack of discussion about the limitations of the cited models (such as the picture viewing paradigm in P. J. Lang, 1995, and by which assumptions it is extended to digital games)—insomuch as there are references to models at all—suggests that that the relationship between different measures and between the measures and theoretical emotional concepts is generally considered as unproblematic. After the review, new relevant papers have been published (such as Poels et al., 2012; Martínez, Garbarino, & Yannakakis, 2011; Garner & Grimshaw, 2013), but the situation does not seem to have changed: the measures' correspondence to theoretical constructs is not considered.

[17] It should be noted that this is not an assessment of the quality of these papers. Most of the ten not referring to any emotion theory were computer science studies that, for instance, attempted to create an automatic classification algorithm for inferring an emotional state from the physiological input. Those probably used the emotion terms in the context of some other field, of which I am not familiar with. However, even in such a case, it seems like a shortcoming if a discrete emotion category defined as the goal was determined by a self-report, without considering whether the report is valid or reliable—or without considering any model how the two (the physiological state and the self-reported class) should be theoretically linked.

One of the ten was my own manuscript, which became Study I. More on limitations, later.

How about other game studies—perhaps psychophysiological studies are a bad sample of all game research in regard to how they view emotions? Most game research outside psychophysiology, when it refers to emotions, uses media research frameworks (see Fang et al., 2010, for a quick review), psychological frameworks (such as Tamborini et al., 2010; or Bartsch, Vorderer, Mangold, & Viehoff, 2008), or models specific to game research field (e.g., Sweetser & Wyeth, 2005), and not emotion theories. While they may present some essential understanding on some aspects of media or game experiences, their common feature is that they are almost entirely conceptual, instead of created from empirical research, and the little empirical research on the specific measures they propose relies solely on self-report. As one of the main points of agreement in the generally contentious field is that emotions manifest themselves in several components, this seems a serious shortcoming.

In conclusion, it seems that there is both methodological and theoretical need for a common framework that would determine the relationships between emotional concepts, physiological measures, and self-report measures, and give some ideas on how emotions could be measured in a digital game context. Next, I aim to present just that.

3.1.2. Framework for emotions and (not) defining emotion (Study II)

Study II presents an overview on the Affect Channel Model of Evaluation (ACME). ACME provides a conceptual tool to understand the formation and construction of emotion—from a series of evaluations, to physiological activation and higher-order contextualizing processes. Briefly, ACME is based on the idea that certain evolutionarily (see Tooby & Cosmides, 2008) primal evaluation processes (closely related to appraisals or stimulus evaluation checks by Scherer, 2009, 2013) constantly evaluate the sensory input automatically and nonconsciously, and when their signature activation patterns are matched, they start response cascades by activating specific affect channels (or process cascades; related to primary processes by Panksepp; see Panksepp & Biven, 2012). The activation of affect channels lead to, if not separately inhibited, changes in the motivational state (or evaluative space, as described in, e.g., Norman et al., 2011, a model developed on the more familiar valence-arousal model; cf. Bradley & Lang, 2007), and finally in the emotional components in a semi-fixed order (cf. LeDoux, 2012; P. J. Lang & Bradley, 2010). ACME posits the existence of low-level neural modules that interact and form affect channels (such as exploration, fear, anger, and lust, following Panksepp & Biven, 2012), which drive the body towards a specific (but contextually modified) adaptive behavior. It assumes the motivational state, which influences and is influenced by the affect channels, regulating the general tendency to approach or avoid by inhibiting or facilitating evaluations that produce responses of same valence. It describes a priority order between the affect channels, based on the timing studies that Scherer and others have done on the order of different appraisals (e.g., Grandjean & Scherer, 2008; van Peer, Grandjean, & Scherer, 2014) and argues for a structure that connects these empirically validated evaluations to the neural modules. ACME is organized to (conceptual) processing levels respective to the complexity of the processing required by the corresponding evaluations: the quicker and evolutionarily earlier modules are more rigid, and the more complex and flexible the evaluation, the slower and less automatic it is. While the current version covers only the very first (both evolutionarily, and temporally in response to a stimulus in a certain situation) evaluations and responses, it assumes that the higher processes include many functionally consistent modules, which might potentially include functions such as social evaluations of coalitions, dominance hierarchies, emotional expressions, reciprocity, and empathy (e.g., Kurzban, Tooby, & Cosmides, 2001; Rand, Greene, & Nowak, 2012), all important for social context effects related to the current topic. As an interesting detail, according to Panksepp, playing has been evolved in mammals for learning social rules and skills (Panksepp & Biven, 2012, Chapter 10).

The model is called a model of evaluation instead of emotion, because—as noted by Russell (2009)—the definition of emotion is ultimately arbitrary: people call certain responses but not others as emotions, because of their cultural status, not because they would be naturally different than some other responses (see the argument against natural kinds: Barrett, 2013). As Lang (1995) found, emotions are motivational—but there is little reason to rule out other motivational states, such as hunger, pain, or vertigo, other than that we are accustomed to do so. By focusing on the neurophysiological function of stimulus evaluation, there is no need to be mired in the useless controversies over what is emotional and what is not (Russell, 2012). Therefore, “emotion” is whatever we call emotion in common parlance, including emotions that populate game experiences, such as enjoyment and frustration. Emotions are produced by the evaluative system, and when we study emotions, we study how the evaluative system functions and how they result in subjective feelings that we sometimes label as emotions. Furthermore, emotions during game experience are no different than other emotions. The earlier the evaluations are, the more automatic they are, so that they occur before the higher processes can evaluate the mediated game context as irrelevant for real-life survival (see A. Lang, 2006). The later evaluations, on the other hand, are influenced by various contextualization processes in any case, regardless of whether the contextualization happens to be “this is a digital game” or “this is a team meeting with my coworkers”.

3.1.3. Measuring emotion, a revisit

Regarding emotion measurements, the existing emotion theories do not provide a clear answer, with reviews coming from different theory families ending up with different conclusions (e.g., Mauss & Robinson, 2009, concluding that the dimensional approach is more appropriate than the basic emotion approach, while others recommending just the opposite; Lench et al., 2011). However, the simplistic approach, like taking the correspondence of physiology and emotion concepts (“ZM EMG = positive affect”) for granted can be considered clearly wrong. This is aptly put in a conclusion for a review on naturalistic studies on facial expressions (see Fernandez-Dols, 2013, for the whole Special Section on facial expressions in regard to emotion; see also a review on smiling: LaFrance, Hecht, & Paluck, 2003):

> “[F]acial expressions cannot be defined as crisp, ‘true’ signals of an emotion, but rather as fast, multiple, and imprecise cues which, nevertheless, are adequate (adaptive) for their senders in a particular situation. A second, no less reasonable conclusion is that such cues are linked to different mental processes. For example, a single emotional episode might include

> simultaneous or successive facial movements linked to affective reactions, appraisals, social motives, or strategies of regulation, but also to cognitive processes or cultural conventions.” (Fernández-Dols & Crivelli, 2013, p. 27)

Systematically mapping out how the reality works is of course essential (see especially the impressive review by Kreibig, 2010), but theory which helps understanding the relationships between different factors influencing the emotion components is better in that it provides explanations and testable hypotheses that drive the research ahead. Although ACME is currently in its infancy, I hope that in time it can be developed into a fruitful theory. For now, it mostly remains a synthesis of previous work—from where we can work out practical applications to current questions, for instance, using the appraisal theories—and a bold suggestion to bind it all together, but already I attempt to apply the grand view as an interpretative framework to the current topic.

In regard to the issue of convergence (or the lack thereof), ACME explains the differences between self-report and physiological measures by the process that produces them. The self-reports are always produced very late in the response cascade, by high-level modules that after the activation has already gone through complex contextualization and conceptualization processes. The physiological responses are the more predictable the earlier they are mobilized. The responses of all modules can be inhibited by conscious effort if the individual anticipates a certain kind of stimulus, but otherwise, the earlier the module, the more direct and consistent the physiological response. A startle response (a reaction to a sudden and large change, such as a loud crash or an object quickly approaching) is the earliest one, and the most consistent: the physiological signals related to it can be used as a paradigm to investigate processes that influence it (as P. J. Lang, 1995, shows). Similarly, evolutionarily relevant stimuli that are hardwired to our brains (such as fear of darkness and spiders, arousing quality of sexual cues, caretaking cues such as big eyes and small bodies that make us go “aww”) produce rather reliable responses as demonstrated by the picture viewing paradigm (Bradley, 2000) and in context of other rather simple stimuli (short unambiguous audio clips and moving pictures; see Ravaja, 2004). Unless the situation has been framed in an unusual way, the correspondence between self-reports and the physiology is adequate, as the physiological responses are automatically launched and the higher processes simply recognize them and thus may report them rather reliably.

However, the less evolutionarily primal the evaluation is, the more it is influenced by the higher-order processes (such as those that contextualize the situation for more complicated evaluation) that bring variation into the physiological responses (by inhibiting hard-wired and replacing them by learned responses) and into self-reporting. The two are not necessarily coordinated, because the subjective and physiological components have evolved for different purposes: the physiological mainly for mobilizing the body for action, and the subjective consciousness mainly for accumulating information from different sources and for sharing that information with others (Dehaene, 2014). The important caveat is that the physiological components is also to some extent subject to processes that take care of social communication: for example overt signals of shame are important for modules evaluating trustworthiness (see Greene, 2014). It is likely that for instance the facial muscle responses captured by EMG measurements result from some of the earliest and most automatic social signaling processes, so that mostly, they work even when nobody is watching. The question whether facial expressions are related to emotions or social communication is old (Parkinson, 2005), and the current wisdom stresses that both should be taken into account (Fernández-Dols & Crivelli, 2013).

Using ACME, a preliminary list of expected relationships and the order in which they should be easiest to measure can be drafted:

- As mentioned, the startle response is expected to be the most consistent in physiological component and least affected by higher processes (and thus the least variable in subjective reports as well); evolutionarily relevant stimuli comes close second, to a somewhat lesser extent.
- Next, events directly related to immediate achieving goals or being obstructed from achieving them. However, this is already confounded by the processes that frame the situation in regard to various social and long-term factors (such as self-image and social status; see also social processes, below). The more immersed the player is, the less these processes affect, and the more consistent should the measurements be.

Yet, it should be noted that while negative response (e.g., frustration) activates as a reaction to an obstruction, the positive responses (e.g., satisfaction?) in a digital game are probably much smaller, because they would be less adaptive if they distracted from the action at the same time as they reward it.

- Especially relevant to the game experience context is the exploration channel, a rather early and automatic dopamine system-based circuitry that includes the play module, responsible for playful behavior (much of which can be conceptualized as following the principle of “predictable but not too predictable”). The exploratory/playful behavior should be accompanied by a low-to-medium level positive activation, which (in absence of other strong activation) should be measurable with self-reports and EDA (but not necessarily EMG, because the exploration is not a social process by origin).
- Social processes, while clearly evolutionarily later adaptations, still include many automatic modules that operate regardless of higher processing (although of course, individual differences may be large). For example, the evaluation of dominance hierarchies may be behind competitive behavior, and strong adherence to them (competitiveness) should increase the intensity of achieving goals or being obstructed from achieving them. Coalitional evaluations, on the other hand, might inhibit them: if the situation is framed as a together-doing with a friend, the immediate goal should be having fun together rather than winning, so responses to both victories and losses might be smaller than in a highly competitive framing (although of course, both processes could be active at the same time, resulting in interactions difficult to interpret). In all social cases, the social display rules present a challenge, as it is difficult to discern whether a particular expression was a response originating from an affective evaluation or a social signaling process (cf. e.g., LaFrance et al., 2003). Notably, the brain likely treats fictional characters to some extent similarly to real social interaction situations (A. Lang, 2006).

As a rough guide, because the evaluative system is primarily an evolutionary adaptation, the logic behind the structure of processes should follow from evolutionary psychology (cf. Kurzban, 2010). Similarly, a more early adaptation is more likely more automatic one, so the less some phenomenon seems to be under conscious control or can be influenced by conscious effort, the more likely it should have reliable responses that can be measured.

3.2. Study III

Study III empirically investigated the phasic emotion-related physiological responses to victory and defeat events in regard to the relationship to the opponent. The main results are illustrated in Figures 3 and 4. Below, I also overview the results using the above theoretical considerations as an interpretative framework.

The original article reported that the victory event elicited a positive response in the local co-presence conditions (Figure 5, top panels, comparing the two grey lines), indicated by the inverse u-form of the ZM and OO EMG signals. Contrary to hypothesis, the victory events when playing against a friend were not experienced more positively than the same events when playing against a stranger, but it was speculated that this may have been influenced by a ceiling effect, that the response to a victory event against a friend was attenuated due to overall positivity level being higher to begin with. Finally, the victory in the virtual co-presence condition over an AI opponent was reported not to show a positive response, which was interpreted that the single-player game, in addition to being different in game structure from the two-player games, was perhaps not very enjoyable to begin with (cf. the tonic results in Ravaja, Saari, Turpeinen, et al., 2006).

The emotion interpretation of these results is not the only one, however, as—considering the ACME framework—it is also possible that the smiles are simply social displays in the presence of another (cf. LaFrance et al., 2003). However, the similar results from earlier studies are highly concordant with the current ones: a success in Monkey Ball (picking up a banana, which is the goal of the game; Ravaja, Saari, Salminen, Laarni, & Kallinen, 2006) and Monkey Bowling (knocking down pins; Ravaja et al., 2005) games elicit the same kind of reaction in a single-player game. Furthermore, the one study whose results are different (killing an enemy character in James Bond showed a decrease in ZM and OO

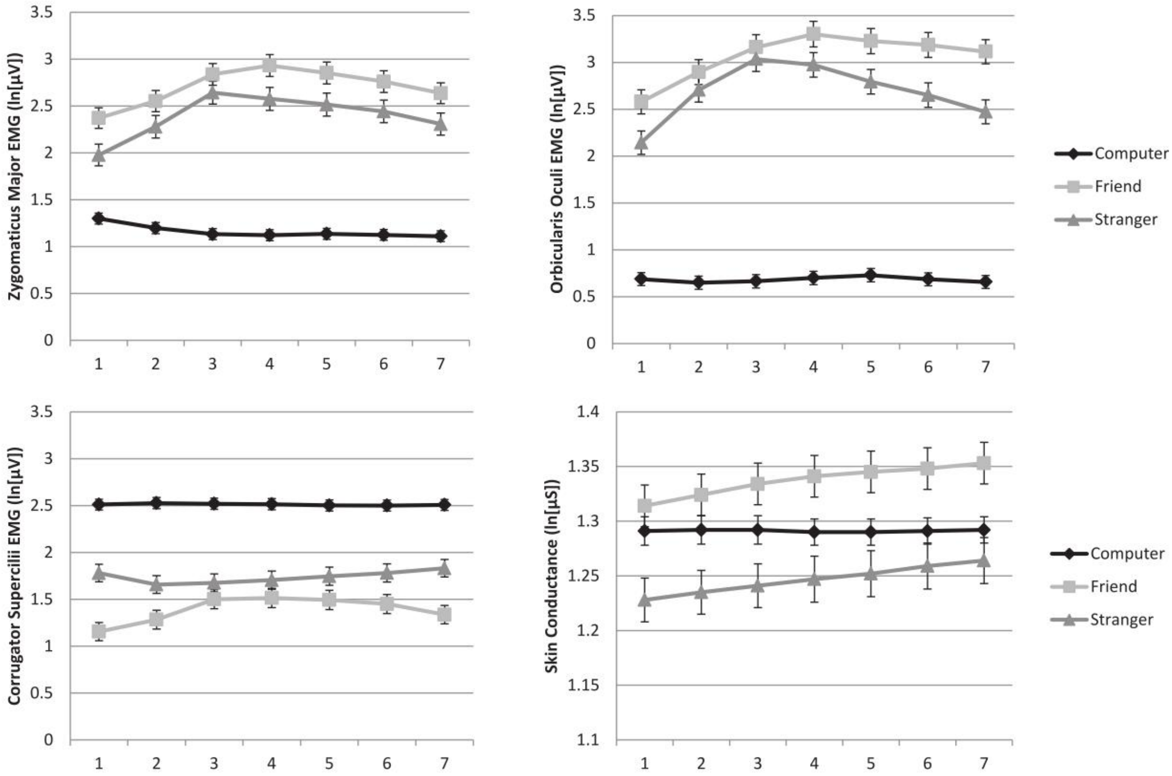

Figure 5 (from Study III). Killing the opponent character event as a function of opponent type. Mean zygomaticus major (top left panel), orbicularis oculi (top right panel), and corrugator supercilii (bottom left panel) electromyographic (EMG) activity, and mean skin conductance level (bottom right panel). Second 1 occurs before the event, seconds 2-7 after. Error bars represent standard errors.

EMG activity; Ravaja, Turpeinen, Saari, Puttonen, & Keltikangas-Järvinen, 2008) actually shows the same pattern as we have here for victory against an AI opponent: my suspicion is that only these two events (a kill of an AI opponent in James Bond and here) do not represent victories in the sense of achievement of a goal, as the AI opponents are more like obstructions for proceeding in the game than actual goals. When the opponent is a human, the situation changes and the kill of the opponent character becomes a real goal.

When looking at the negative responses to victory events, responses inverse to the positive responses were expected; however, it was found that the event produced a CS EMG response when the opponent was a friend, suggesting a negative emotional reaction, and no particular response when the opponent was a stranger (Figure 5, bottom left panel). Assuming that this was not a chance finding, three potential explanations were offered in the original article for this intriguing result: the apprehension that the person regarded as close might not experience the situation positively while the feelings of the distant person would not be cared for similarly; the possibility that the security of social closeness might allow for stronger displays of negative emotion, implying that the response was suppressed when playing against a stranger; and the evaluation apprehension effect (produced by the knowledge that they were monitored) that might be stronger when in presence of a friend. All these possibilities have their strengths and problems, but in the end, the explanation might be much simpler than that, when we remember that the assumption of a direct relationship between CS EMG activity and negative affect is faulty. The signal might be an index of frustration in many contexts, but in the presence of a friend, social motives should be stronger than in the other two conditions, supporting the interpretation that facial expressions are also influenced by social communication processes. Smiling mouth with the furrowed brow could be associated with a kind of determined pleasure when your efforts to beat a dear rival bear fruit, something akin to schadenfreude or gloating. However, while in research these feelings have been linked with envy (Cikara & Fiske, 2012), in game research the corresponding emotion has been reported as genuinely positive (see de Kort & IJsselsteijn, 2008, pp. 4–5), and it can be seen in the good-natured teasing, boasting, and payback-mentality (see descriptions of competition in Sherry et al., 2006; and Poels, Kort, & IJsselsteijn, 2007). The notable difference is that emotion research has typically conceptualized schadenfreude in the context of rivalry as serious competition of status (Cikara & Fiske, 2012; Leach, Spears, & Manstead, 2015), not as good-natured rivalry between friends. This difference would explain the result in the original article, with the positive response from victory elicited by both stranger and friend as an opponent, but the CS EMG response, arguably indicating this “friendly schadenfreude” and not negative emotion per se, only elicited by the victory over friend as it would be too risky to signal in the presence of a stranger. This interpretation would also support the interpretation that the smiles during victory are indicative of positive emotion after all, because one would

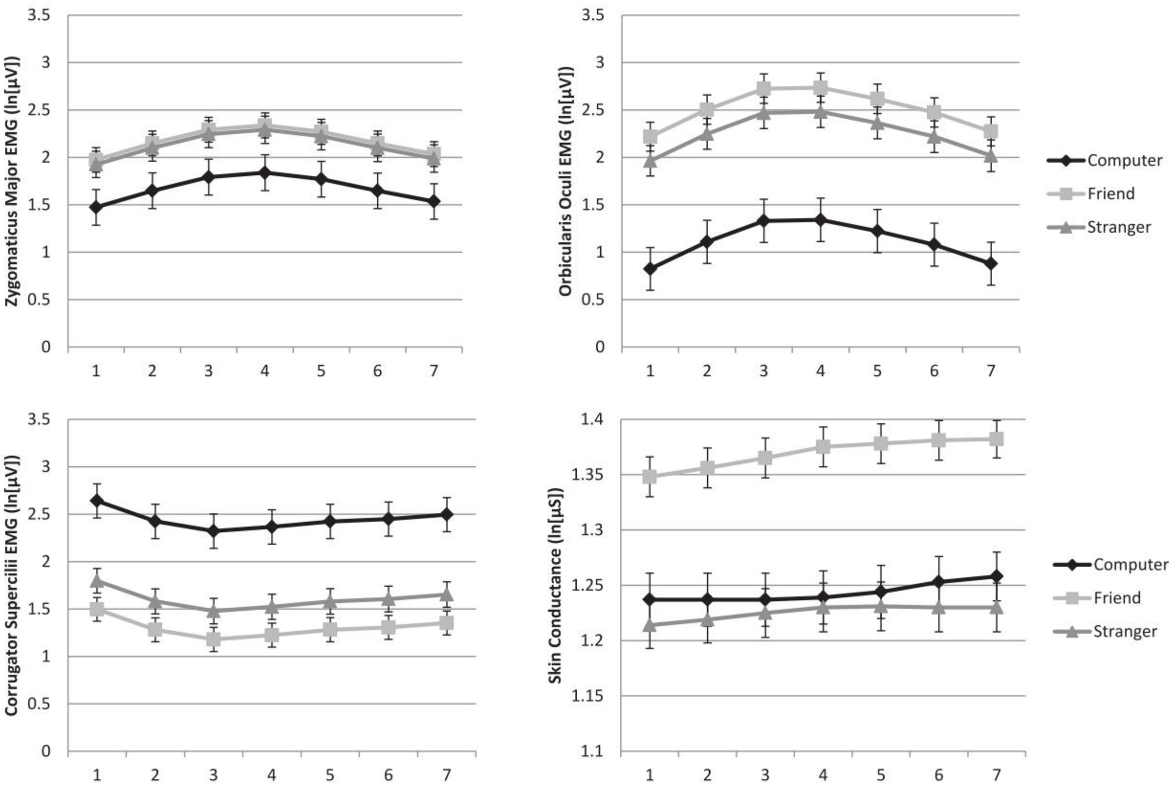

Figure 6 (from Study III). Death of own character event as a function of opponent type. Mean zygomaticus major (top left panel), orbicularis oculi (top right panel), and corrugator supercilii (bottom left panel) electromyographic (EMG) activity, and mean skin conductance level (bottom right panel). Second 1 occurs before the event, seconds 2-7 after. Error bars represent standard errors.

presumably not gloat (even friendlily) if one was not actually enjoying the victory.

Defeat events replicated the earlier results that losing elicits, regardless of the opponent, an increase in ZM and OO EMG activity (Figure 6, top panels) and a decrease in CS EMG activity (Figure 6, bottom left panel), ostensibly indicating positive emotion. This same effect has been found several times in various digital game studies (Ravaja et al., 2005; Ravaja, Saari, Salminen, et al., 2006; Ravaja et al., 2008; van den Hoogen, Poels, IJsselsteijn, & de Kort, 2012), and in at least one economic game (Ravaja et al., 2015). Offered explanations for the counterintuitive EMG responses have included visual impressiveness and excitingness (Ravaja et al., 2005), positive challenge or rewarding feeling of surviving a symbolically dangerous situation (Ravaja, Saari, Salminen, et al., 2006), transient relief from engagement (Ravaja et al., 2008), and challenge feedback (van den Hoogen et al., 2012). In Study I, I also originally suggested the transient relief explanation. Yet none of these suggestions can be applied to the rather simple context of economic game, where the participant simply chooses to cooperate or not cooperate, and depending on what the partner (in this case, a virtually co-present representation of an AI) chose, either won money or lost it. While getting the results might have been exciting (although the low value of the prize, a couple of euros, suggests it was not), there is no immersion in a virtual world, no dangerous situation, no engagement, no challenge. Again, a more plausible explanation might be social communication instead of emotion: smiling as a result of framing the situation as social, where the response to a rather insignificant outcome of the competition is overcome by the importance of showing 'face' in a situation that could otherwise be interpreted as threatening (see Table 5 and intercorrelation between competition and presence of others, in a review by LaFrance et al., 2003). By smiling, the participants (most likely unconsciously and automatically) signal that the competition was not important to them and that its results should not affect others (i.e., trustworthiness cues; cf., Vigil, 2009; see also LaFrance et al., 2003).

3.3. Study IV

Study IV, reporting Experiments II and III, investigated the self-reported and physiological effects of the player roles (competitive or cooperative), their interaction with the gender, the effect of location (in Experiment 2), and the comparison between local and virtual co-presence (in Experiment 3). The main results are illustrated in Figures 7 and 8.

In both experiments, and after controlling for various confounds, competition was associated with higher ZM and OO EMG activity than cooperation for males, but not for females (Figure 7, top panels; Figure 8); in Experiment 2, self-reported joviality (the discrete emotion corresponding to high arousal and positive valence in the used questionnaire) and valence repeated this pattern (Figure 7, bottom panels). In Experiment 3, self-reports did not differ between competition and cooperation, but further analyses suggested that this was probably confounded by the higher responses to the explicit announcement of the winner. In contrast, despite the cultural

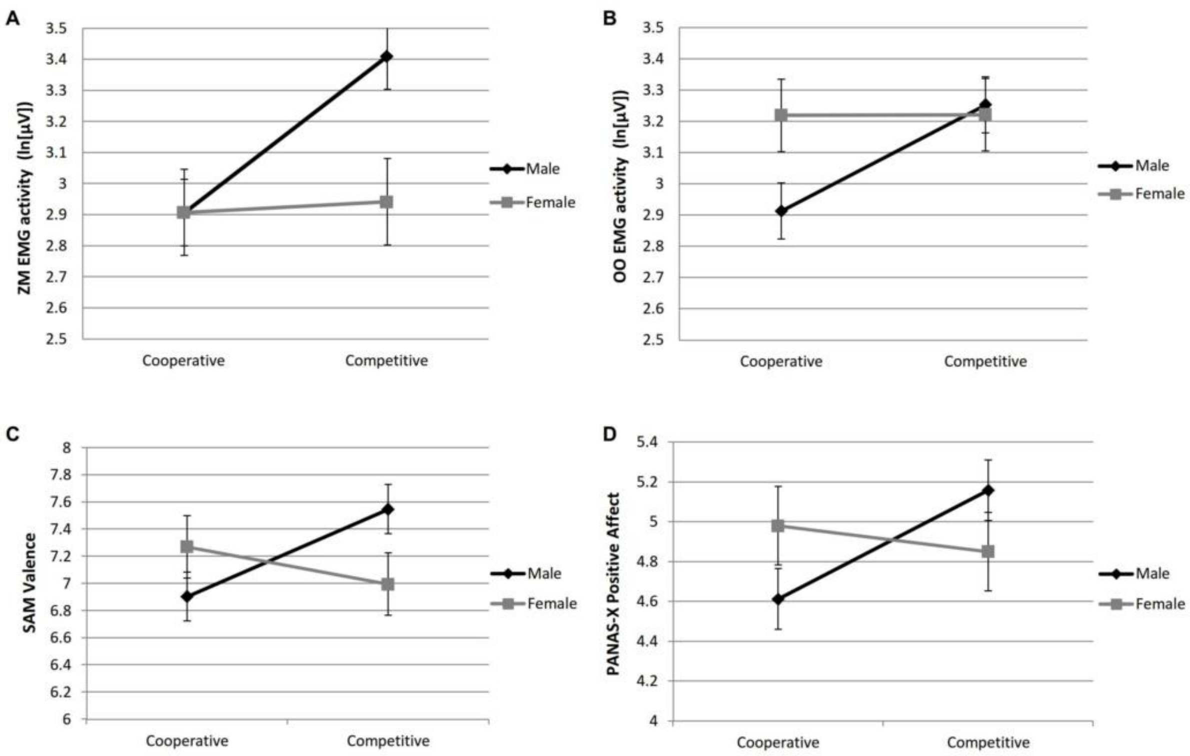

Figure 7 (Study IV Figure 1). Gender differences in zygomaticus major (top left panel) and orbicularis oculi (top right) EMG activity, both associated with positive emotion, and self-reported pleasantness (bottom left) and positive affect (bottom right), across cooperative and competitive modes (Experiment 2). The error bars represent standard errors.

assumptions, females did not show higher EMG activity, nor did they report higher joviality or valence, in cooperation. CS EMG activity and self-reported fear, hostility, and (in Experiment 2 only) sadness did not vary across genders, although there was a difference in fear and sadness between cooperation and competition (fear being higher in competition, and sadness in cooperation, in Experiment 2 only). Together, these results suggest a difference in positive emotion between cooperation and competition, but for males only.

From the perspective of ACME framework, it is a problem that tonic physiological measurements aggregate over all the responses across a long period of time, because most likely the results are an amalgam of activity from many different processes and inferences specifically related to one source are suspect. This is problematic especially when comparing cooperation and competition—one which can be interpreted as low- and other as high-threat in regard to need to signal positivity.

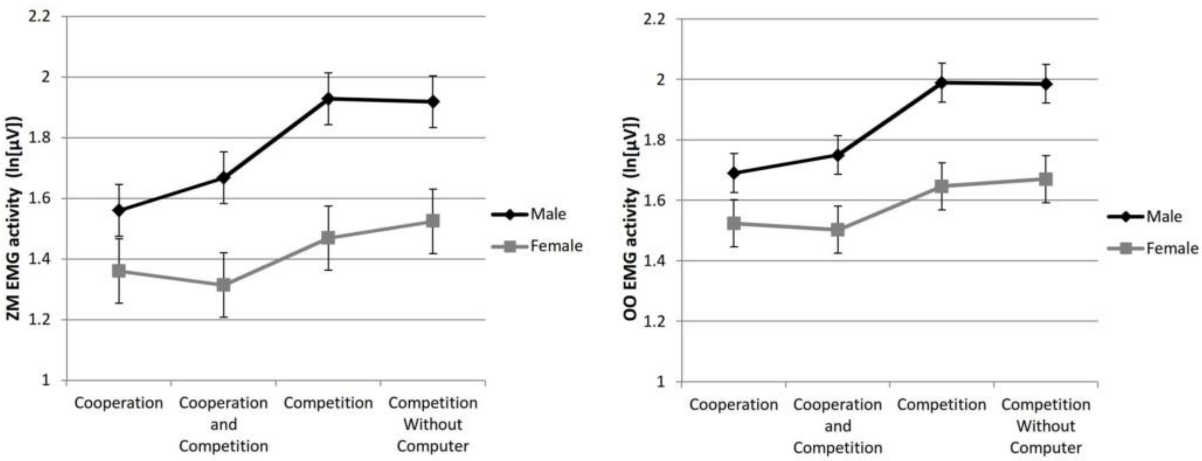

Figure 8 (Study IV, Figure 3). Gender differences in zygomaticus major (left panel) and orbicularis oculi (right panel) EMG activity, both associated with positive emotion, across the four conditions representing different modes of competitiveness (Experiment 3). The error bars represent standard errors.

However, the convergence between physiological and self-report measures suggest that probably at least part of the tonic EMG activity reflects (positive) emotional processes. From the earlier studies, both Schmierbach and others (2012) and Emmerich and Masuch (2013) have reported more self-reported enjoyment or positive affect in competition. The former did not report that they tested gender differences at all, but the latter explicitly reports that no gender differences were found—although only in terms of statistical significance (a practice often criticized, see Cumming, 2014; Kline, 2013), so whether there was even a weak tendency is not known. Notably, the self-reports had markedly weaker effects than the physiological signals in our sample as well, and the study also notes that according to the relevant review, females should be smiling more in a social signaling situation (LaFrance et al., 2003). Considering these points, my interpretation is that the results can be plausibly considered to indicate differences in emotions.

Interestingly, in both experiments the social presence self-reports showed higher empathy and lower negative feelings in cooperative, compared to competitive conditions (and psychological and behavioral involvement following the empathy in Experiment 3 only)—the former showing the opposite and the latter the similar patterns to positive emotions. This is contrary to what the SCF would predict (as it assumes that social presence is experienced positively), but exactly the same finding that Emmerich and Masuch (2013) reported. Noting that the negative feelings subscale includes items related to schadenfreude and vengeance, the finding also supports the interpretation for Study III that some amount of gloating and payback mentality in a friendly competition is not experienced as negative but positive.

Results for arousal were conflicting, as the SCL did not show any effects in either experiment, while HR was higher in competition for males in both experiments, and self-reported arousal was higher in competition for males in Experiment 2 only. Both Ravaja (2004) and Kreibig (2010) mention that HR, in addition to arousal, is also associated with (active) positive emotions, which may explain the discrepancy. Earlier studies are not much of a help, as one (Schmierbach, 2010) reported higher arousal in competition for males while the other (Velez et al., 2012) in turn reported the opposite result for mode but no difference for gender. These results remain unclear.

As for the other context factor, the results indicated no difference between home and laboratory in terms of employed measures, in Experiment 2. The effect of virtual instead of local co-presence (in Experiment 3) was not present in physiological measures (Figure 6), but self-reports suggested—regardless of gender—lower joviality, valence, dominance, and arousal, and higher hostility, but not fear, in the condition with the AI virtual presence, as compared to playing without AI in the game. An examination of free comments suggested that this might have been due to the unpredictability and uncontrollability of the AI player. Regarding the theoretical background, appraisal theories name predictability and controllability as important appraisals (Scherer, 2001; Roseman, 2013), but their prediction is that low level of these factors should result in fear—exactly the one self-reported emotion that was not affected. ACME, in turn, links these evaluations as part of the goal-orientation channel, which activates the anger channel, in accordance with the current results.

3.4. Study V

Study V investigated the practical significance of physiological and self-report measures in predicting subsequent play behavior and preference. The study was an extension to an earlier study by Poels and others which had made a claim that there might be a direct association between pleasure and short-term playing behavior, and arousal and long-term playing behavior (Poels et al., 2012). The study was based on the concept of hedonic consumption, of which one interpretation basically says that people do not consume things only because it is rational, but also (and sometimes only) because it somehow gives us pleasure (Alba & Williams, 2013). However, it is not obvious that our motivation to consume something would show so simply in the level of pleasure (interpreted as positive valence unproblematically measured by self-reports and psychophysiological methods). The literature on gaming motivations (are competition, satisfaction of intrinsic needs, effectance, or the other constructs really reducible to simple average valence?), questions about genre preferences (would tragedy enthusiasts really show highest pleasure for tragedy?), and our everyday experience pose challenges to this idea.

We created an almost identical experimental design and followed the same methods as Poels and others, but we extended the analyses in respect to the literature showing that positivity and negativity should be considered relatively independent (e.g., Norris, Gollan, Berntson, & Cacioppo, 2010). However, the study still assumes an uncomplicated relationship between emotions and both self-report and physiological measures. What is the plausibility of interpreting the results as signals of emotions? Using tonic averages over long experimental periods, it is clear that the variety of processes influencing the physiological signals is significant. In addition, the games used in the experiment were more complicated than what are typically used (e.g., in Studies III and IV): especially the cinematic thriller game Fahrenheit and the comedy adventure Sam & Max, but also the plot advanced by cinematic cutscenes in Painkiller and Operation Flashpoint (although to smaller extent) rely on a narrative, which is a rather abstract stimulus processed by evolutionarily much more late-developed brain processes than simple achievement responses—suggesting that the separation of physiological responses and subjective feelings may be considerable. On the other hand, playing alone, the lack of direct social context should at least decrease the likelihood of complications from social processing.

Interestingly, the descriptive statistics (Table 1 of Study V) still show a surprisingly high correspondence between self-report and physiological data—

and the expectations based on the nature of the games. The game highest in self-reported pleasure (the comedy adventure Sam & Max) also showed the highest mean ZM and OO EMG activities and the lowest CS EMG activity, while the game with the lowest pleasure (the military FPS Operation Flashpoint) shows the highest CS EMG activity (but no difference in ZM or OO EMG activities). Self-reported arousal, on the other hand, corresponds with the maximum SCL instead of the mean (lowest on Sam & Max). Because ACME currently does not extend to how narratives are processed, there are no theoretical expectations other than the possibility (but not necessity) of larger discrepancy between the measures among the higher processes. These findings, however, lend the basic credibility for interpreting physiological signals as at least partly associated to emotion.

Study V found, first, that the characterization presented by Poels and others was overgeneralized, as we found completely different predictive associations in our sample. Obviously, the different games influenced the results, but this only shows that the predictive power of the measures is not invariant of what kind of games are used. Second, it was found that pleasure should not be considered as a single bipolar dimension (valence) but instead as two relatively independent dimensions with their own predictive power, in line with theories and further evidence for the emotional interpretation. Particularly, related to a straightforward but challenging military shooter both high positive and low negative activity predicted play behavior, but related to a plot-based thriller game, low positivity predicted play behavior (and negativity was not associated with it at all). Third, the study found indications that more complex games may be predicted by more complex emotions, such as meta-emotions (Bartsch, Appel, & Storch, 2010)—as shown by the association between low positivity and play behavior, which suggests that those who did not find the game particularly positive played it more likely (cf. Andrade & Cohen, 2007), although this is highly speculative. However, a similar finding was reported by Emmerich and Masuch (2013), who noted that when given the choice, more participants chose to play a game mode that was previously rated as less positive. Fourth, we learned that the effect sizes of the predictions may be rather high (βs up to almost .50 per SD), yet quite selective (only some game-outcome variables are predicted). In principle, the different types of games should elicit different response patterns simply because the dominant evaluation processes during them are different. For example, a humorous adventure game without any reason to hurry cannot rely on intensification of emotional responses to achieving or obstructing goals by exploiting (non-social) threat evaluations, as presumably the more action-oriented games do (see Study II). However, the extremely long tonic aggregation of signals makes this very difficult, as even very different kinds of games vary in their content.

A further important contribution of this study was to report results in natural units, demonstrating the practical significance of the findings. Showing that both self-reports and physiological measures can be linked to intuitively comprehensible effects (such as hours of play) with a tolerable confidence (as estimated by confidence intervals; Cumming, 2014) makes the measures more practically meaningful for readers outside of academia (such as from game industry).

4. General discussion

4.1. Overview of the results

The sociality characteristics framework was interpreted to present three social context factors: the physical and digital features of the setting (including laboratory vs home), the presence and the type of presence of others (including local vs. virtual), and their relation to the player in the play situation (including competition vs. cooperation) and outside it (including relationship to the opponent, and gender). According to the SCF, the first of these factors was assumed to determine the social affordances, which, in turn, determined the sense of social presence, or how the presence of others was experienced.

While the framework presented the general relationships between the factors and the outcomes, it did not present any specifics about what effects might be in practice influencing the game experience. In this dissertation I have reviewed the existing literature and organized the known results according to the framework, so that we now have the information on some likely effects practically operating within the framework. On the empirical side, this dissertation has further contributed to this knowledge by presenting new research results for some of the most important factors (see below). On the theoretical side, this dissertation has overviewed the emotion theories and critically reviewed the common measures in the field, to improve understanding on what we mean by ‘emotions’ and what can be said about the measures, and ultimately in order to improve understanding of the empirical results (our own and of others). Furthermore, the new emotion-theoretical framework I introduced can be adopted for a broader use in game research or outside it.

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Study I reviewed the game research papers using psychophysiological methods, and my results from analyzing the papers indicate that the general awareness of the researchers in the field about the theoretical and empirical justification of their methods is quite poor. Most often, it is taken for granted that the physiological measures index emotions, without considering why or how, or what emotions are. Next, introducing Study II and my synthesis of the emotion theories, I presented the theoretical framework—called Affect Channel

Model of Evaluation—that provides a new view on what emotions are, how self-report and psychophysiological measures are related to them, and what kind of emotional processes might be plausibly investigated in which kind of circumstances. As a return to the methodological considerations, Study V suggested that while self-report and physiological measures can predict future playing behavior, the predictions cannot rely on simple linear effects related to pleasure or arousal, and they cannot disregard the fact that the play of different kinds of games are probably predicted by different measures.

Regarding the empirical studies, Experiments 1 (Study III), and 2 and 3 (Study IV) investigated the following social context effects related to the sociality characteristics framework.

Relationship to opponent. Study III reported the phasic effects of the relationship to opponent on the game experience. The earlier studies about the relationship factor have not investigated the phasic responses to relevant events, so these findings are pioneering in showing that the differences are not only on tonic level, but extend to responses to individual events. The responses to a victory plausibly represent positive emotions which were similar regardless of whether the opponent was a friend or a stranger. This lack of difference is contrary than what has been found earlier, but this might be explained by a simple ceiling effect. In general, the positive emotion finding is similar to other victory events in earlier studies.

Based on the new interpretative framework offered by ACME, I proposed that the simultaneous CS EMG response (when the opponent was a friend) rather points to an expression of a friendly schadenfreude or rivalry (an interpretation that is supported by results of Study IV, below) than a negative emotion. Although there are no relevant similar results in the earlier papers, the proposal to interpret EMG responses in a wider context than simply direct signals on emotion is novel.

Finally, we replicated the earlier findings of a ZM EMG response to defeat, with new information that this apparently occurs regardless of opponent. But again, the novel interpretation is that this is a simple social signal in a potentially threatening situation. When considering the evidence, this is the most logical explanation.

Competition vs cooperation and Gender as a background variable. Study IV, reporting results from two experiments, concluded that competition was experienced more positively by males, but no difference between modes for females. The convergence between different measures and with previous studies suggests that even if social signaling processes are influencing the physiological measures, the emotional processes are likely active as well. The results repeat what has been found in earlier studies to a certain extent, but the total sample size from the two experiments, the extensive control of confounding variables, and the consideration of different theoretical explanations make the results much more credible.

The arousal measures in Study IV were inconclusive, although there are indications that the discrepancy between SCL and HR could be resolved if HR, in this context, would be interpreted to be associated with positive emotion rather than arousal.

Social presence. In Study IV, the social presence subscales for empathy and involvement were found to be higher in cooperative modes rather than competitive, but notably opposite to positive emotion measures. This is contrary to what can be expected based on the SCF, but it is supported by at least one earlier study.

Furthermore, the so-called negative feelings subscale (including items for schadenfreude and vengeance) was higher in competitive modes, in line with positive emotion measures, supporting the idea of friendly rivalry (and again supported by an earlier study). Although mentioned several times in the game research literature anecdotally, to my knowledge this is the first empirical finding of this concept. In addition, in the field of emotion research the concept does not seem to have been considered earlier.

Local vs. virtual co-presence. Study III reported the phasic responses to essential events in relation to the opponent, although because the control of the stimulus was not adequate, these results are merely conjectural. Similar to the tonic results reported in earlier studies, the victory events were experienced more positively when the opponent was a human (local co-presence) as compared to the AI (virtual co-presence). Defeat events elicited a large ZM EMG response regardless of the opponent, but as explained above, this was most likely not indicative of emotional processes.

Study IV compared the presence versus absence of AI in the competitive condition of Experiment 3, and found that self-reports, but not physiological measures, indicated higher positive and lower negative emotions during the absence of AI. However here, also, the results are suspect, because the free reports from the participants suggested that the behavior of the AI was particularly unsatisfactory.

In total, the results on local vs virtual co-presence are in line with earlier studies, but not particularly convincing due to methodological problems.

Laboratory vs home of one of the participants as environment. Experiment 2 in Study IV tested the influence of environment (home vs. laboratory), and reported that no differences were found as main effects or in interaction with other variables. The earlier studies have been somewhat conflicting, but the tendency has been that home is rated more positively (or less negatively) than school, café, or mobile environment (public transportation). I have no explanation for this discrepancy.

4.1.1. Interpreting the social context factors

Although the sociality characteristics framework helps in identifying the social context factors and their effects, it falls short from presenting a testable model. A model, drawing together all the knowledge and organizing it into a coherent whole with defined relationships between the parts, would be enormously useful in research, and it would also offer concrete benefits for game designers. The SCF could not be that model because there was not enough knowledge about the parts and relationships yet; I do not believe that the current knowledge is enough even now, but we have taken steps into the right direction. Thus, the following is not intended as such a model.

The rudimentary sketch of what such a model could be, shown in Figure 9, is a conceptualization of my current understanding of the social context factors and their effects on social game experience. As in the SCF, the physical and digital setting features shape the social affordances, which filter the influence of the presence of others on the social game experience: without social affordances, the presence of others cannot have any influence. The relationships (in the physical world) and roles (in the digital world) in their own turn modify the influence: if the person is annoying, the influence may be negative, while if the person is a dear friend, it is likely strongly positive; similarly, if the roles in the game force the interaction into a mold, such as competition by some particular rules, the influence is modified according to the experiencer's preferences about that interaction (apparently, a male might consider competition more positively). The setting also determines the ways the others can be present.

As can be seen in the figure, social presence is entirely missing from it. According to the SCF, if my interpretation is correct, social presence would be another filter along the influence arrow, limiting how the presence is perceived, but at the same time influencing the experience by itself. However, in my current understanding (and this comes with the disclaimer that I am not familiar with the existing social presence literature), this conflates two different functions that are for some reason binned under the common name of social presence. In one hand, there is social awareness (close to what is called co-presence in Biocca & Harms, 2003), simply the understanding of what the social

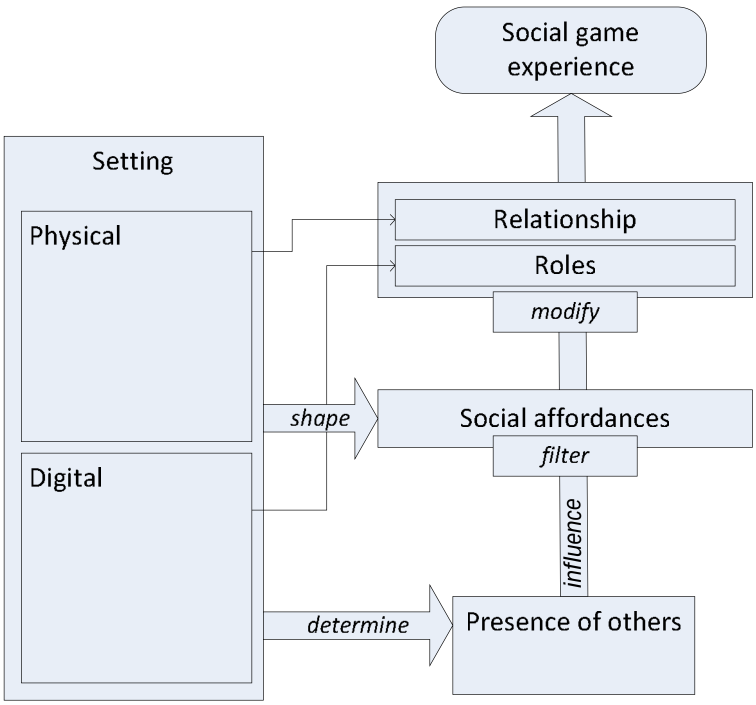

Figure 9. A rudimentary sketch of a possible model for mapping social context effects.

situation with the other is—this could be depicted as the very tip of the influence arrow in Figure 9. On the other hand, there is social involvement, which covers the effects de Kort and IJsselsteijn (2008) discuss, such as empathy, behavioral mimicry, and so on. But this is not the same process as the social awareness; rather, I would place it inside the social game experience box. Where social awareness is, in a way, a passive understanding at the situation, social involvement is the active (although probably mainly unconscious) results of that understanding in interaction with the experiencer's personality, goals, attitudes, and so on. In terms of ACME, social awareness is the evaluation, while the involvement is the subjective feeling and the behavioral tendency resulting from an affect channel that gets mobilized by the evaluation. This assessment of the position of social presence is in part affected by the findings that social presence (as it is now measured) certainly does not seem to act like it affects the influence arrow, as I understand the SCF suggests—instead, it seems to be affected by it. For example, it is easily imaginable that the awareness is high but the involvement is low, such as in a case of an anxiety-inducing other, where the high awareness leads to immobilization and withdrawal from the activity rather than more engagement[18].

In principle, the relationships between different parts could be examined experimentally. For instance, it should be easy to diminish the effects of the other person's influence by varying what kind of communication affordances the setting creates. Also, it should be interesting comparing different relationships than simply friend and stranger—for example, relationships that have the potential to modify the influence negatively, like the anxiety created by a person higher in social hierarchy. Still, I offer the above conceptualization not as a final product, but mainly as a discussion starter and a step in the research agenda to investigate the social context effects more comprehensively.

[18] Involvement could be interpreted as any kind of influence, also negative, which would dispute this point. However, typically the involvement is considered to be positive engagement with the other, not avoidance, as is shown by the assumptions that social presence is in itself a positive experience (de Kort & IJsselsteijn, 2008).

4.1.2. Interpreting emotions

In this dissertation I reviewed the use of emotions measures in game research, and found that when emotion theories are cited, they are too often taken as granted, and the caveats specifically laid out in those cited articles are often ignored. Although I recognize the bother of reading or writing the same disclaimers in every article that cites a particular model, it is important to recognize the theoretical link of measures and the emotional concepts—to understand exactly what can be inferred from the measures, what cannot, and what are the grounds for doing so. Ignoring this link might lead to misinterpreting the results, but also to giving a false idea to future (especially junior) researchers.

ACME indicates that the closer the evaluated situation is to the evolutionary survival-related stimuli, the more directly the physiological responses result from it. A typical game content, while possibly containing some elements of survival stimuli (such as darkness, startling surprises, or cute baby-like characters), is rather far away from that and therefore may operate with a somewhat different set of rules (see also A. Lang, 2006). The physiological responses can be indicative of emotional processes, as I have interpreted in parts of this work, but they should not be assumed so uncritically.

4.2. Limitations

4.2.1. Study I

As mentioned, Study I did not report the exact search words that were used, nor could it (due to the word limit) report every relevant article. The classification (that I already criticized for using such a badly chosen name as “validity” studies) is rather baseless, and in many cases the overview on the papers seems to paint an unjustifiably rosy picture about the state of the field. The focus, apart from just listing the papers that have used a particular methodology in the particular field, is unclear. Admittedly, that was the focus at the time because there was confusion about what the “field” or its state exactly is, but with a bit ambition, it could have been also something much more useful, making a larger point in order to make future research better. In addition, some kind of quality focus might have been in order, limiting out the least rigorous studies or the least plausible publication venues—currently, the source or its credibility is not considered at all in the main text. (Thankfully, the predatory journals did not exist yet to the extent that this would have been a major problem—now it is just a matter of putting workshop working papers and quality journal publications in the same bin.)

Although I use Study I here for demonstrating the lack of theoretical rigor in the game research field, it itself is a prime example of a paper that does not report properly the theoretical limitations that psychophysiological measures face—and more than in a random article reporting an individual empirical experiment, this is a serious flaw in a review that was intended as a common reference material. There is a lack of theoretical depth, with discrete and appraisal theories mentioned along the dimensional models, but the references are twenty years old and are not contextualized in a big picture. Even more serious for a review on methodology, there is also the lack of methodological depth, uncritically repeating the typical connections, but not their limitations, and the relevant alternative interpretations (such as the social communication view) are touched only very lightly without really discussing them. To be fair, it is commendable that even within the word limit, there is almost a page of methodological considerations right in the beginning about the difficulty of using digital games as experimental material and the importance of proper experimental control.

Finally, the statistical rigor leaves much to hope for as well. The article does mention the need for a suitable sample size (even in the face of the fact that psychophysiological measures are extremely laborious and really satisfactory sample sizes relative to the weakness of the target effect sizes are nearly never acquired), but other considerations, such as the importance of using effect size estimators, are not mentioned. In addition, the call for new, less broken statistical methods and less inherently biased reporting practices has only gained weight recently (see Kline, 2013; Cumming, 2014; Simmons et al., 2011) so it is not a shortcoming that we were not able to see the future at the time, but today, these points would be essential.

All in all, Study I, like Study III, reflects the degree of my inexperience at the time, which, I suppose, can be also seen as positive development that I now know better.

4.2.2. Study II

In contrast to Study I, Study II represents the most current research I have to offer, so I do not yet have the benefit of hindsight and accumulated knowledge to assess the work itself critically.

Currently, ACME only considers (some of) the very first and quickest response patterns to stimuli. The emotional components are influenced to large extent also on higher levels, but without a clear theoretical source that would have systematized their operation, I do not know enough to make even preliminary suggestions of their integration.

Considering the enormity of the mission that Study II was set out for—creating a synthesis of the known emotion research in order to make the whole more accessible and conceivable—it is inevitable that I have missed some essential articles that I do not know of or recognize yet. In this time, I could not have even read everything that is available from the very key authors, Scherer, Panksepp, Russell, and Cacioppo (and others). Due to the importance of psychophysiological methods, perhaps Lang and other psychophysiologists would have been equally important. It just happened to all click together with the works that I have currently cited, that either there really is something to the common basis of all these theories, or otherwise it all simply seems to fit because I know so little about them.

I recognize that my knowledge in the relevant fields is lacking. Coming from psychophysiological game research, there is a world of neuroscience and emotion psychology that I am not aware of. An especially grave shortcoming is that I know so little about evolutionary psychology: I am aware of the main principles, but I do not know the methods and or have the understanding of what is proper research on the field (as there are often-heard mentions of bad evolutionary psychology). Even on my home turf, psychophysiology, I feel hopelessly unlearned due to the need of having to spread my attention across several multidisciplinary borders to be able to do game experience research.

I fully acknowledge that it is entirely possible that the whole ambitious creation that is ACME is ridiculously off the mark due to the fact that I simply do not know enough to understand why. However, for overly critical readers I wish to stress that the rather abstract theoretical vision that is Study II is not all there is to ACME—I mentioned earlier my unpublished manuscript (Kivikangas, n.d.). Originally I wrote this rather lengthy manuscript on the specifics of how Panksepp's, Scherer's, LeDoux's, Russell's, and Cacioppo and others' works relate to each other at a much greater degree of detail than what is reported in Study II. It remains until that manuscript is peer-reviewed that the real basis of ACME gets tested.

4.2.3. Study III

Looking at Study III theoretically, the overly direct inference from physiological responses to positive or negative affect is in principle unwarranted. However, according to my interpretation of ACME, the events in question here—victory and defeat—also happen to be prime examples of game events manifesting the evaluations of achievement or obstruction of goals (based on goal-conduciveness by Scherer, 2001). With this theoretical background, the interpretation of physiological signals as indices of positive and negative affect is not unreasonable (regardless of how I interpreted some results in the end).

Although no worse than a typical game experience study, naturally the limitations of rather small sample size (both the number of participants and the number of final non-overlapping events) and its representativeness, only one stimulus game representing a very specific type of games, on one (now outdated and less relevant) platform, apply. The generalizability to other people, other games, and other game events may be questionable. Yet, the coherence of the gained results with earlier studies with other people (although typically very similar in demographics) and different games with a different content—especially the positive response to a victory (cf. Ravaja, Saari, Salminen, et al., 2006) and as mentioned earlier, the large ZM and OO EMG response to defeat (e.g., Ravaja et al., 2008; van den Hoogen et al., 2012)—suggest that the results are not idiosyncratic to this particular experiment. Of course, this does not mean that the interpretations are the correct ones. A new study exploring the events should consider including appraisal measures to make sure that the events are actually experienced as assumed.

4.2.4. Study IV

Study IV does acknowledge social processes as different interpretations for the physiological signals, but there is still a degree of taking the measures for granted. Again, though, the convergence with earlier studies lends credibility.

Two experiments investigating the same question give better evidence than one, but the difference between the experiments could have been controlled better. Although the main results for EMGs are the same, it is possible that the confusion concerning arousal originates from how different the two games are.

In total, the sample size was adequate, but individually, the samples and the gender ratios in experiments investigating a gender difference (30:18 and 50:32 of male:female in Experiments 2 and 3, respectively) were more skewed than one could hope for. Particularly, the number of females in Experiment 2 was clearly too low—especially as the games were played in dyads, which creates a dependence in the data. However, this reflects the fact that recruitment of female participants of equal previous gaming experience than males is difficult or impossible. Here also we had considerable differences in gaming experience, and though statistical techniques can be used to circumvent the problem, it introduces a difference in the sample that might influence the results.

Statistically (and this applies also to Study III, and to a slightly lesser extent, to Study V), the analyses and reporting should use methods more in line with current recommendations (e.g., effect size estimations and confidence intervals; Cumming, 2014) in order to better assess the plausibility and practical significance of the results. Furthermore, in hindsight I am a little concerned about whether I might have unconsciously exploited the flexibilities in analyses and reporting to create a better story (Simmons et al., 2011), and how that may have influenced the quality of my science. In our funding scheme, it is not really feasible to follow the prototypical path of creating hypotheses from theory and testing them (and only them) in an experiment. In practice, experiments have been most often designed to overextend significantly from the original research questions, because what the funding is for is not always the scientifically most interesting topic—for example, the experiments in Study IV were not designed originally to study gender differences. Yet, collecting hoards of data and later ending up to analyzing and reporting some parts of them does create a large possibility for false positive psychology, which Simmons criticizes and which is currently debated as a crisis of the whole psychology as science.

4.2.5. Study V

As a practical example of the problems of how experiments are practically designed and what are the final end results, Study V was originally designed together with the Poels et al. study it is now written to answer, in a project where both of us collaborated. Due to practicalities of publishing studies, they happened to publish their results first. In an alternative that was completely possible, we might have published first, and they would have then written their paper to answer ours, as if it was designed to do just that. Not only is it a poor feature of the current publishing system that the mere order of publishing changes the narrative the studies are framed with, but in the worst case, it also skews the results. I might argue that in our case it actually improved the quality of our manuscript, because seeing the other study first allowed me to think critically and improve those parts (mainly analyses) that I still could.

For the stated purpose of Study V, the design is lacking. A direct replication with the same games (but with the more nuanced analyses included in Study V) could have examined whether the found associations hold, which would have given much better understanding of the effects. As we could not choose the games according to knowledge we only had after reading the Poels study, the choices seem somewhat suboptimal. To specifically test the conclusions of Poels et al. (2012), a systematic experiment could have been conducted by choosing the games so that the measurable pleasure and arousal would have been varied in a 2x2 factorial way, while finding participants to four groups so that each group's preferences would have varied by game genre (regardless of pleasure and arousal). If my suspicions are correct, the results could have been that different groups would have played their preferred game genres rather than those that would have had the highest pleasure and arousal. Of course, this setup assumes that measurable pleasure and arousal can be actually predetermined which would have needed some pre-screening, but I would expect it is possible to some extent (e.g., intense horror for high arousal, a comedy game for high positive valence, etc.).

In regard to the games picked for the study, some of them (particularly Fahrenheit and Sam & Max) for the first time included game characters that are observed as actors in a narrative, and interacted with in a social context. This raises the question about interpreting the facial EMG results, as even a virtual character might be considered a social actor making the automatic evaluations activate social signalling processes (e.g., Weyers, Mühlberger, Hefele, & Pauli, 2006; A. Lang, 2006). As it is difficult to find out what kind of virtual social situations the participants have encountered and how have these influenced the total average of EMG measures, it is impossible to assess the extent of this effect.

An obvious shortcoming in regard to this dissertation is that Study V only used single-player games. A comparison of single-player and social games would have provided a valuable addition to the current work.

4.3. Practical implications and future directions

The practical implications of my work can be relevant in academia, in game industry, and in the society in large. In game research, the social context factors should be studied further, in which case the current results provide evidence for future research endeavors. More often, though, social context factors act as confounds when studying other parts of the game experience, or other effects of playing digital games. In these cases the understanding of potential sources of error to the data is important, and the researchers can benefit from the current empirical results, and from my conceptualizations when the empirical results are lacking but some kind of understanding would be helpful.

A specific interesting finding was the empirical evidence of schadenfreude related to friendly rivalry, which seemed to be a new idea to the emotion research that has considered schadenfreude primarily as a negative emotion related to envy (Leach et al., 2015). One possibility is that this could be related to the difference between voluntarily engaged competition (playing games for fun, see intrinsic motivation; Ryan & Deci, 2000) and a forced competition such as competition in a job market: in the former, the goal is to have fun, so losing is not a threat but simply part of the activity, while in the latter, winning is the goal and losing means that the goal cannot be achieved, resulting in negative emotions (see appraisals, e.g., Roseman, 2013). However, voluntary engaged competitions can result in similar negative emotions as well, such as in committed supporters of sports teams (e.g., Kerr, Wilson, Nakamura, & Sudo, 2005). The other option, inspired by appraisal theories, could be that the relevant difference is in whether the competitors are considered as one's ingroup and therefore not as a threat, or as one's outgroup and potentially threatening for one's goals and needs. This is only speculation, though, as the topic is not my expertise.

In the game industry, the knowledge of both phasic responses to certain events (and the conceptualization of why these events are important) and tonic levels of activity in certain broader conditions can be useful. For example, recently the game industry has introduced free-to-play games that have a different kind of revenue generation model, which also creates a completely new game experience by constantly involving real money within play. Only a small portion of companies have managed to utilize this to create games worth playing that simultaneously bring in unprecedented amount of money; the vast majority stumble because they do not understand how to make the relationship between paying and playing both profitable and enjoyable. Detailed knowledge on the moment-to-moment playing experience and paying experience would likely be an enormous help. In this sense, the work of mapping the effects of context factors (e.g., what is the influence of co-players regarding how socially present they are in the game, where the game is played, state and traits of the player) in relation to game experience—and how that experience is used so that both the player and the game's creators are happy—is just a beginning. In addition, the research like the one presented here, pioneering in prediction of play behavior based on game experience, is another crucial piece in this puzzle.

The evidence that there may be differences in game experience between genders is significant in a broader context of gaming culture and questions of equality. Currently, there is a lot of discussion how women are marginalized in the gaming culture, but also in the contents of games themselves.

Acknowledging that the results are tentative (only one study in addition to mine has reported gender differences in regard to competition and/or cooperation: Schmierbach, 2010; the differences are well established in behavioral economics, but without considering the difference between voluntary and involuntary competition; Niederle & Vesterlund, 2008; Andersen, Ertac, Gneezy, List, & Maximiano, 2010) and reminding possible non-scientifically oriented readers that they are statistical (they tell very little about the tendencies of an individual), studies about gender differences in game experience might show one way to help finding the features in games that contribute to the marginalization. I do not suggest simplistically that "girls should be made more cooperative games" per se without better evidence—it is very much possible that the differences in emotions, even if they are characteristic for females, do not translate directly to playing preferences (see Study V, in which we found just that). But I do call for more research that could explore what kind of features are strongly dispreferred by female players. For instance, Hartmann and Klimmt (2006) reported that, unsurprisingly, sexual gender stereotypes make young women dislike gaming, but that the most relevant factor was lack of meaningful social interaction—that is, the lack of social context, or the lack of right kind of social context (cf. Kuznekoff & Rose, 2012, who reported that a female received three times as much harassment in a multiplayer game played over internet)—followed by violent content (see also Terlecki et al., 2010).

Other context factors may have larger implications for the society, but the one obviously important for games is the level of co-presence, which was only superficially touched in this work. It is hardly any news anymore that a multiplayer game is experienced as more positive than a single-player game (although the fact that this difference is also present at the level of phasic physiological responses is not previously known). However, the context factors that influence this are very poorly known. What, exactly, makes a multiplayer game a more positive experience? Many people, on the other hand, explicitly do not like multiplayer games—why? Some of these factors have been already discussed—whether it's competitive, cooperative, or something in between; the number of players; the roles within the game (is everyone the same in regard to in-game capabilities or are there systematic differences, such as character classes? Is someone more powerful than others, and why?)—but to my knowledge there is no systematic review of all the different factors. The research question I am proposing is enormous in the sheer volume, but only systematic work and widespread collaboration can tackle these kinds of fundamental issues. My work here was a mere scratch on the surface, attempting to cover a couple of central questions.

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